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NATIONAL DAM SAFETY PROGRAM. MORRISTOWN RESERVOIR DAM (NJ 00352--ETC(U)
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DELAWARE RIVER BASIN
HARMONY BROOK, MORRIS COUNTY
NEW JERSEY

LEVEL II

MORRISTOWN RESERVOIR DAM
NJ 00352

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

March, 1979

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

16 MAR 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Morristown Reservoir Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Morristown Reservoir Dam, a high hazard potential structure, is judged to be in fair overall condition. The spillway is considered inadequate since 11 percent of the Probable Maximum Flood (PMF) would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial actions should be completed within three months from the date of approval of this report:

1. Sluice gates and operators should be made functional.

2. Remove sedimentation and plant growth in the discharge flume and stilling pond.

3. Repair or replace ladders into the gatehouse structure.

4. Investigate and repair toe drains and provide clear drainage routes to the stilling pond.

5. Investigate and determine the extent of possible voids under the concrete spillway apron and correct conditions that may lead to seepage and loss of support.

6. Remove, replace and repair the concrete lining of the discharge flume.

7. Remove the timber flashboard across the discharge channel culvert under Woodland Road to prevent the possible restriction of spillway storm overflows.

d. The following remedial actions should be completed within six months from the date of approval of this report:

1. Plug animal burrows in the downstream face of the dam.

2. Investigate and develop control measures for the seepage in the chlorination house.

3. Riprap the upstream slope of the secondary dike.

e. The following remedial actions should be completed within twelve months from the date of approval of this report:

1. Depressions in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam.

2. Spalls and cracks in the concrete spillway apron, gatehouse structure and footbridge should be repaired.

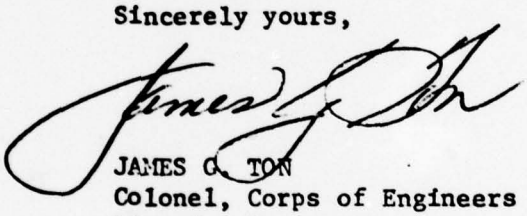
NAPEN-D
Honorable Brendan T. Byrne

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congresswoman Millicent Fenwick of the Fifth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,



1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Cy furn:
Mr. Dirk C. Hofman, P.E.
Department of Environmental Protection

MORRISTOWN RESERVOIR DAM (NJ00352)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 22 November and 1 and 5 December 1978 by Langan Engineering Associates, Inc. under contract to the State of New Jersey. The state, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, P.L. 92-367.

Morristown Reservoir Dam, a high hazard potential structure, is judged to be in fair overall condition. The spillway is considered inadequate since 11 percent of the Probable Maximum Flood (PMF) would overtop the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system, should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. The following remedial actions should be completed within three months from the date of approval of this report:

1. Sluice gates and operators should be made functional.

2. Remove sedimentation and plant growth in the discharge flume and stilling pond.

3. Repair or replace ladders into the gatehouse structure.

4. Investigate and repair toe drains and provide clear drainage routes to the stilling pond.

5. Investigate and determine the extent of possible voids under the concrete spillway apron and correct conditions that may lead to seepage and loss of support.

6. Remove, replace and repair the concrete lining of the discharge flume.

7. Remove the timber flashboard across the discharge channel culvert under Woodland Road to prevent the possible restriction of spillway storm overflows.

d. The following remedial actions should be completed within six months from the date of approval of this report:

1. Plug animal burrows in the downstream face of the dam.

2. Investigate and develop control measures for the seepage in the chlorination house.

3. Riprap the upstream slope of the secondary dike.

e. The following remedial actions should be completed within twelve months from the date of approval of this report:

1. Depressions in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam.

2. Spalls and cracks in the concrete spillway apron, gatehouse structure and footbridge should be repaired.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 16 Mar 1979

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	MORRISTOWN RESERVOIR DAM
ID NUMBER:	FED ID No. NJ00352
STATE LOCATED:	NEW JERSEY
COUNTY LOCATED:	MORRIS
STREAM:	HARMONY BROOK
RIVER BASIN:	DELAWARE
DATE OF INSPECTION:	22 NOVEMBER 1978 1 and 5 DECEMBER 1978

ASSESSMENT OF GENERAL CONDITIONS

Morristown Reservoir Dam is in fair overall condition. There are wet areas on the downstream face of the dam and along the toe of the dam. The concrete of the spillway has spalled and cracked in several areas. It is likely there are voids beneath the spillway apron and possibly the spillway weir. The discharge flume has deteriorated to the extent the channel is ineffective with respect to carrying heavy flow. Seepage is occurring from the floor of the chlorination house. Sluice gates in the gatehouse do not operate properly. The spillway capacity as determined by CE Screening criteria is inadequate. We estimate the dam can adequately pass only 10% of the PMF.

We recommend removing the vegetal growth in the discharge flume and stilling pond. The improperly operating sluice gates and operators should be investigated, made functional, and maintained. The ladders into the gatehouse structure should be repaired or replaced. The toe drains should be investigated and repaired and clear drainage routes to the stilling pond should be provided.

The extent of possible voids under the spillway apron should be investigated and conditions that may lead to seepage and loss of support under spillway should be corrected. The concrete lining of the discharge flume should be repaired. The flashboard across the culvert under Woodland Road in the discharge channel should be removed. The preceeding recommendations should be done very soon. Animal burrows in the downstream face of the dam should be plugged and protection provided against future animal burrowing into the embankment. Seepage occurring in the chlorination house should be investigated and control measures developed. These recommendations should be done soon. The secondary dike slope should be riprapped. Sags in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam. Spalled and cracked concrete at the spillway, and the gatehouse structure and footbridge should be repaired. The actual degree of stability of the dam should be determined using appropriate material properties and analytical methods. These recommendations should be done in the near future.

The spillway capacity as determined by CE screening criteria is inadequate. The actual capacity of the spillway should be determined using more precise and sophisticated methods and procedures. If necessary steps should be taken to increase the spillway capacity. The need for and type of mitigating measures should be determined. Around the clock surveillance during periods of unusually heavy precipitation should be provided, and a warning system established. This should be done soon.

Dennis J. Leary

Dennis J. Leary, P.E.

OVERVIEW

MORRISTOWN RESERVOIR DAM

1 DECEMBER 1978

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM:	MORRISTOWN RESERVOIR DAM
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LANGAN ENGINEERING ASSOCIATES, INC.

Consulting Civil Engineers
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CLIFTON, NEW JERSEY
201-472-9366

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NATIONAL DAM SAFETY REPORT

MORRISTOWN RESERVOIR DAM FED ID No. NJ00352

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SECTION 1 PROJECT INFORMATION

1.1 General

Authority to perform the Phase I Safety Inspection of Morristown Reservoir Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 20 November 1978. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineer District, Philadelphia, Penn.

The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to the safety of Morristown Reservoir Dam and appurtenances based upon available data and visual inspection and, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted. The assessment has been made using screening criteria established in Recommended Guidelines for Safety Inspection of Dam prepared by the Department of Army, Office of the Chief of Engineers. It is not the purpose of the inspection to imply that a dam meeting or failing to meet the screening criteria is, per se, certainly adequate or inadequate.

1.2 Project Description

The Morristown Reservoir Dam is a 1460-ft-long, 60-ft-high earthfill structure with a concrete core wall and a 26-ft-wide crest. It was constructed between 1929 and 1932 across Harmony Brook. The upstream face is riprapped to within 5 ft of the crest and 6 ft below the normal reservoir level. The upstream and downstream slopes are 3 hor to 1 vert and 2½ hor to 1 vert.

The concrete core wall extends from its rock foundation where it is about 9 ft wide to three feet below the crest where it tapers to 1.5 feet. Available drawings show the wall has a batter of 1 hor to 20 vert on both sides.

A gatehouse with dimensions of 15 ft by 30 ft in plan and 44 ft high is located 70 ft upstream from the centerline of the dam crest. The gatehouse has 6 sluice gates. Water passing through the gates is carried by means of pipes passing through the dam to a chlorination house for treatment. This house is about 50' downstream from the toe of the dam.

There is an ungated 60-ft-long overfall type concrete spillway at the left side of the earth dam.

The spillway discharge channel is 380 ft long and empties into a stilling pond that discharges into a culvert under Woodland Road. Downstream of the culvert is Harmony Brook which runs through 77 acres of preserved land called the "Dismal Harmony Brooks Natural Area."

The reservoir commonly called the Clyde Potts Reservoir impounds an area of 44 acres and is oriented in a northwest direction. The reservoir capacity is 1052 acre-ft and is used as a municipal water supply. A regional vicinity map and essential project features are presented in Figure 1 and Figure 2.

The Morristown Reservoir is classified as being of "Intermediate" in size on the basis of its height of 60 ft which is greater than 40 ft but less than 100 ft in height. It is classified as "Small" on the basis of its reservoir storage volume of 980 Ac-ft which is greater than 50 Ac-ft but less than maximum 1000 Ac-ft. The overall size classification is the larger of these two determinations and accordingly the dam is classified as "Intermediate" in size.

The Morristown Reservoir Dam is classified as having "High Hazard Potential" on the basis that failure of the dam would cause excessive property damage to residences downstream, and could potentially cause more than a few deaths. Visual inspection of the downstream shows that breach of the dam would cause damage to residences and could be hazardous to people using Brookside Road. It is proposed the "High" hazard potential classification not be changed.

The dam and reservoir are owned by the Southeast Morris County Municipal Utilities Authority, 101 Western Avenue, Morristown, N.J., 07960.

The purpose of the dam is to impound water to be used as a municipal water supply for Morristown, N.J.

1.3 Pertinent Data

a. At dam site, the drainage area is 1,374 Acres (2.15 sq mi)

b. Discharge at Dam Site

Ungated spillway capacity at maximum pool elevation (at low point of dam):	650 cfs

c. Elevation (ft above MSL)

Top Dam:	Elev 663.5 (low point)
Maximum pool-design surcharge:	Elev 663.5 (low point of dam)
Normal pool:	Elev 661.3 (spillway crest)
Streambed at centerline of dam:	Elev 590 (estimated)

	Maximum tailwater:	Elev 594 (estimated)
d.	Reservoir	
	Length of maximum pool:	1950 ft (estimated)
	Length of normal pool:	1900 ft (estimated)
e.	Storage (acre-feet)	
	Normal pool:	900 AF
	Top of dam:	980 AF (estimated)
f.	Reservoir Surface (acres)	
	Top dam:	38.2 AF
	Maximum pool:	38.2 AF (top of dam)
	Spillway crest:	36.7 AF
g.	Dam	
	Type:	Earth embankment with concrete core wall. Riprap upstream, seeded downstream.
	Length:	1460 (including spillway)
	Height:	60 ft (maximum)
	Top width:	26 ft
	Side Slopes:	Upstream 3H to 1V. Downstream 2.5 H to 1V.
	Zoning:	None Observed
	Impervious core:	Concrete core wall. Top 18" wide. Sides battered 1:20. Bottom 9 ft wide at max depth.
	Cutoff:	None observed
	Grout curtain:	None Observed

h. Spillway

Type:	Overfall; trapezoidal cross-section with anchored flashboard.
Length of Weir:	60 ft
Crest elevation:	661.3 ft

i. Regulating Outlets

Type:	C.I. pipes; one-18" blow off pipe and two-12" supply pipes. Control gates in reinf. concrete gatehouse. All embedded in concrete cradle resting on solid bottom of excavated trench.
Length:	Approx. 400 ft
Closure:	Valves in chlorinating house. 6 Rodney Hunt Gates: 2 at high elevation at 670, 2 at mid height el. at 655, 2 at low height el. at 640.
Access:	Chlorinating house.

SECTION 2 - ENGINEERING DATA

2.1 Introduction

The Morristown Reservoir Dam was designed by the Town of Morristown, N.J. Engineering Department and Mr. Clyde Potts was the engineer-in-charge.

Construction was performed under the direction and supervision of Mr. Potts and the Water Committee of the Board of Alderman of the Town.

There is very little specific engineering data in the available records concerning the properties of the dam foundation and materials. The records do contain sufficient topical reports and descriptions of construction conditions to indicate that sound engineering judgement was used that was appropriate to the state of the art at the time the work was done.

2.2 Regional Geology

Morristown Reservoir Dam is located in the New Jersey Highlands physiographic province. The New Jersey Highlands extend across the State in a northeast/southwest direction from the border of New York to the Delaware River and includes the northwest portions of Hunterdon, Passaic, and Morris Counties and the southeastern parts of Warren and Sussex Counties. This province is part of the New England Physiographic Province and lies between the Appalacian Ridge and Valley Province to the northwest and the Piedmont Province to the southeast, See Fig 3.

The Highlands are characterized by rounded and flat-topped northeast/southwest ridges and mountains up to 1,400 ft high separated by narrow valleys. The orientation of the valleys are usually, but not always controlled by the underlying geologic structure.

Bedrock of the region is predominently Precambrian gneisses, schists, and metasediments. Some sedimentary strata, typically sandstones, shales and conglomerate have been infolded and infaulted into the valley bottoms.

The regional geologic structure reflects the very old age of bedrock. A number of regional faults cross the area in a northeast southwest direction, including the Ramapo Fault; the more than 30 mile long fault/scarp forms the eastern border of the province. Faults control many of the river valley orientations. The relatively uniform slope of the mountain elevations, from northwest to southeast, is a direct result of the faulting. The entire area is part of the now dissected Schooley Peneplain.

The Pleistocene Age Wisconsin glacier covered all of the dam site area.

The glacier stripped most of the existing overburden and weathered rock and uncovered the numerous hard bedrock knobs and ridges seen throughout the province. Most of the side-slopes in the area are covered with heavy boulder tills (ground moraine), whereas glacial outwash and recent alluvium cover the valleys.

2.3 Site Geology

The geology along the centerline of the dam is reported by Meredith & Johnson in their 28 October 1929 memorandum to the State Water Policy (Appendix Ref. 22). It is based on conditions encountered in digging the foundation for the core wall.

The major portion of the core wall trench encountered granite-gneiss intruded by pegmatite. Other portions of the trench disclosed a clayey till above the rock. The till consisted of fragments of granite-gneiss imbedded in a finely ground up mixture of clay and sand. In the central part of the trench the rock was identified as Losee Gneiss and at the northwest side of the trench the rock resembled Pochuck Gneiss which is widely distributed throughout the Highlands area of New Jersey. At the southwest end of the trench the rock is reported to have fairly strong fractures striking north 65 degrees west and dipping 85 degrees to the north. In the central part of the trench the rock is less fractured and strikes north 35 degrees west and dips 62 degrees to the northeast.

SECTION 3 VISUAL INSPECTION

The Morristown Reservoir Dam is in fair condition. It was recently inspected by the owners engineers, Elson T. Kilam Assoc., Inc., on 20 June 1978. A copy of their inspection report is given in Appendix 1. Mr. Phillip A. Wood, P.E. of Elson T. Kilam Assoc. accompanied us during our inspection. He participated in the 20 June 1978 inspection.

Wet areas were observed along the area of the toe drain system. In addition, there is a large wet area downstream of the right abutment. The stilling pond downstream of the spillway discharge flume has overgrown and there is a timber board across the culvert leading from the pond and under Woodland Road. The downstream spillway apron sounds hollow when the concrete surface is hit with a geologic hammer; there may be void space below the concrete. The concrete lining of the spillway downstream apron and flume has cracked and has been displaced by vegetal growth. The flume lining has been severly broken up. The spillway crest has been effectively increased by an anchored flashboard. No data is available concerning the breakaway capacity of the anchors. The concrete spillway sidewalls show deterioration and cracking.

There is insufficient riprap on the upstream slope of the secondary dike and the crest of the dam is used as a roadway which has developed ruts and depressions. There are animal burrow holes in the downstream face of the dam.

Two of the operators for the high in-take gates do not work and operation of the gates at mid-height is questionable. The steel ladder leading down into the gatehouse has deteriorated. Hatches to the gates can not be readily opened. There are cracks in the concrete of the footbridge and support pier leading to the intake structure. Seepage is occurring from the floor of the chlorination house.

The former construction diversion channel contains two concrete pipes that feed run-off to the spillway discharge flume.

SECTION 4 OPERATION PROCEDURES

The owner's engineer informed us the dam has no formal operating procedures. Repairs are made as determined to be necessary.

Operation and maintenance of the dam is the responsibility of the Town of Morristown.

SECTION 5 HYDRAULIC/HYDROLOGIC

The hydraulic/hydrologic evaluation is based on a Spillway Design Flood (SDF) equal to the full Probable Maximum Flood (PMF) in accordance with the evaluation guidelines for dams classified as High Hazard and Intermediate in size. Hydrologic design data for this dam is not available. The PMF has been determined by developing a synthetic hydrograph based on the maximum probable precipitation of 22.3 inches (200 square mile - 24 hour). Hydrologic computations are presented in Appendix 4. The PMF peak inflow determined for the subject watershed is 10,169 cfs.

The capacity of the spillway at pool elevation equal to low point of the dam (El. 663.5) is 650 cfs which is significantly less than SDF.

Flood routing for the PMF indicates the main dam section will overtop by 1.1 ft. However, the low spots in the vicinity of the spillway will overtop by 1.9 ft. We estimate the dam can adequately pass only 10% of the PMF.

The downstream potential damage center (residential dwellings), is located a few hundred feet from the dam. Based on our visual inspection of the immediate downstream topography, and the dam and knowledge of the degree of overtopping potential it is our opinion that dam failure resulting from overtopping is not likely. However, if the dam were to fail from overtopping, it is not likely there would be a significant increase in the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

Drawdown of the reservoir has been evaluated considering that the blow-off supply pipes are utilized for lowering the lake. Our calculations indicate that the lake level could be lowered 40 ft in approximately 10 days.

SECTION 6 STRUCTURAL STABILITY

Our visual observations indicate the general stability of the embankment to be adequate. There is insufficient available information to analytically evaluate the degree of stability of the embankment. However, our review of the construction records lead us to believe the stability of the embankment is within present day safety margins. The presence of possible voids under the spillway discharge apron and the severe deterioration of the spillway flume indicate that under extreme flood conditions these structures will be unstable. If voids exist under the spillway apron there is a strong likelyhood that voids are also present beneath the spillway weir. This could cause the weir structure to be unstable during extreme flood conditions.

The Morristown Reservoir Dam is located in Seismic Zone 1 of the Seismic Zone Map of Contiguous States. The static stability of the embankment is assumed to be within conventional safety margins and to present no hazard from earthquakes. However, the spillway structures are likely to experience significant additional damage from an earthquake and are considered unstable with respect to seismic loading until repairs and maintenance work is performed on these structures.

SECTION 7 ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Assessment

The Morristown Reservoir Dam is in fair condition. There are wet areas on the downstream face of the dam and along the toe of the dam.

The concrete of the spillway has spalled and cracked in several areas. It is likely the spillway apron has voids beneath it. The discharge flume has deteriorated to the extent that the channel is ineffective with respect to carrying heavy flow. Seepage is occurring from the floor of the chlorination house. Sluice gates in the gatehouse do not operate properly.

The spillway capacity asdetermined by CE Screening criteria is inadequate. We estimate the dam can adequately pass only 10% of the PMF.

7.2 Recommendations/Remedial Measures

We recommend the following remedial measures:

1. Remove vegetal growth in the discharge flume and stilling pond. This should be done very soon.

2. Improperly operating sluice gates and operators should be investigated, made functional, and maintained. This should be done very soon.

3. Repair or replace ladders into the gatehouse structure. This should be done very soon.

4. Investigate and repair toe drains and provide clear drainage routes to the stilling pond. This should be done very soon.

5. Investigate and determine the extent of possible voids under the spillway apron and correct conditions that may lead to seepage and loss of support under spillway. This should be done very soon.

6. Remove, replace and repair the concrete lining of discharge flume. This should be done very soon.

7. Remove flashboard from across the culvert under Woodland Road in discharge channel. This should be done very soon.

8. Completely plug animal burrows in the downstream face of the dam and provide protection against future animal burrowing into the embankment. This should be done soon.

9. Investigate and develop control measures for the seepage occurring in chlorination house. This should be done soon.

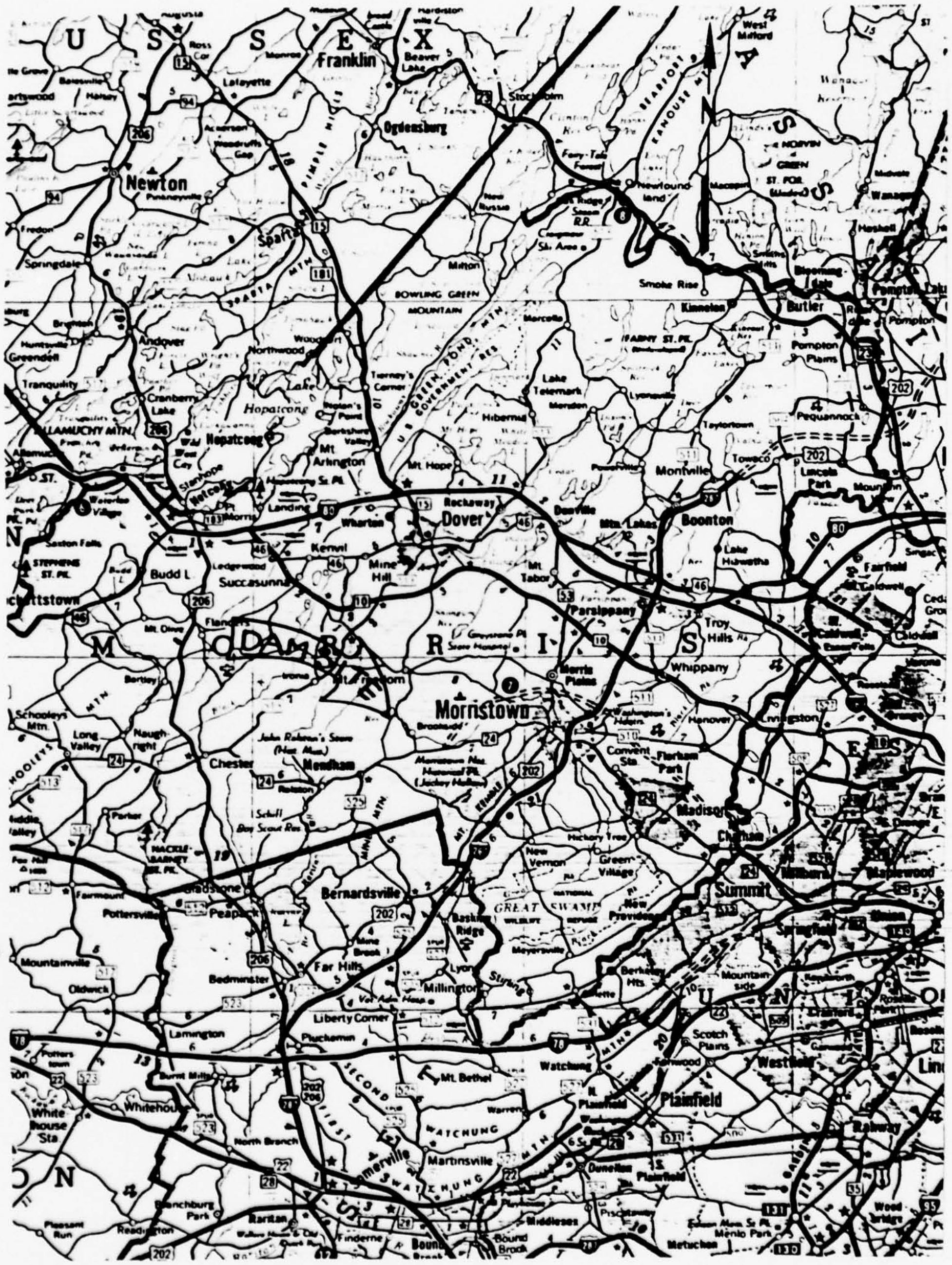
10. The secondary dike slope should be riprapped. This should be done soon.

11. Sags in the roadway along the crest of the dam should be suitably backfilled and adequate road surface material provided at the top of the dam. This should be done in the near future.

12. Repair the spalled and cracked concrete at the spillway, and the gatehouse 12.Investigate by means of borings, piezometers, and tests the engineering properties of the dam and foundation materials. This information should be used to evaluate the degree of stability of the dam under different stress conditions. This should be done in the near future.

13. Repair the spalled and cracked concrete at the spillway, and the gatehouse structure and footbridge. This should be done in the near future.

14. The spillway capacity as determined by CE Screening criteria is inadequate. The actual capacity of the spillway should be determined using more precise and sophisticated methods and procedures. If necessary steps should be taken to increase the spillway capacity. The need for and type of mitigating measures should be determined. Around the clock surveillance during periods of unusually heavy precipitation should be provided, and a warning system established. This should be done soon.

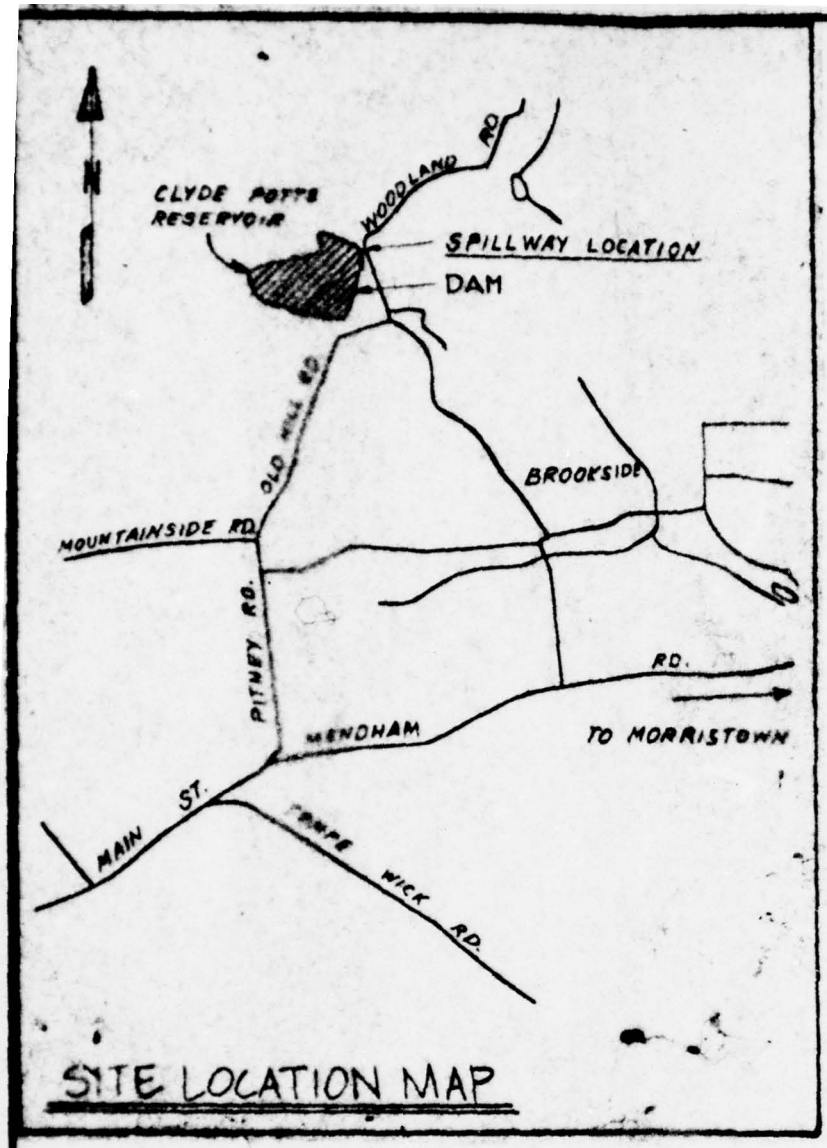


1 in ≃ 5.2 mi

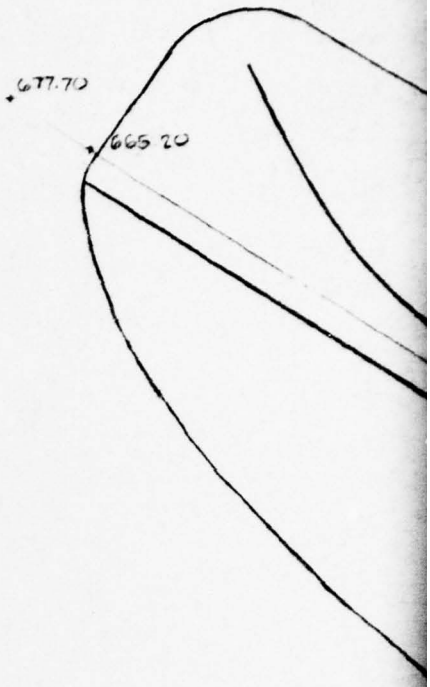
REGIONAL VICINITY MAP

MORRISTOWN RESERVOIR DAM

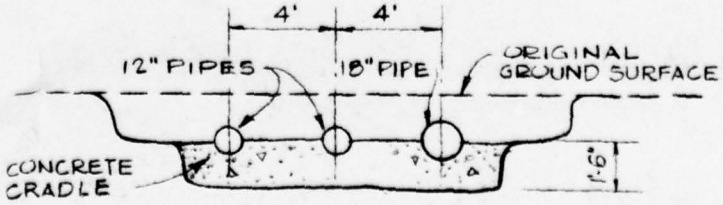
Fig. 1



SITE LOCATION MAP



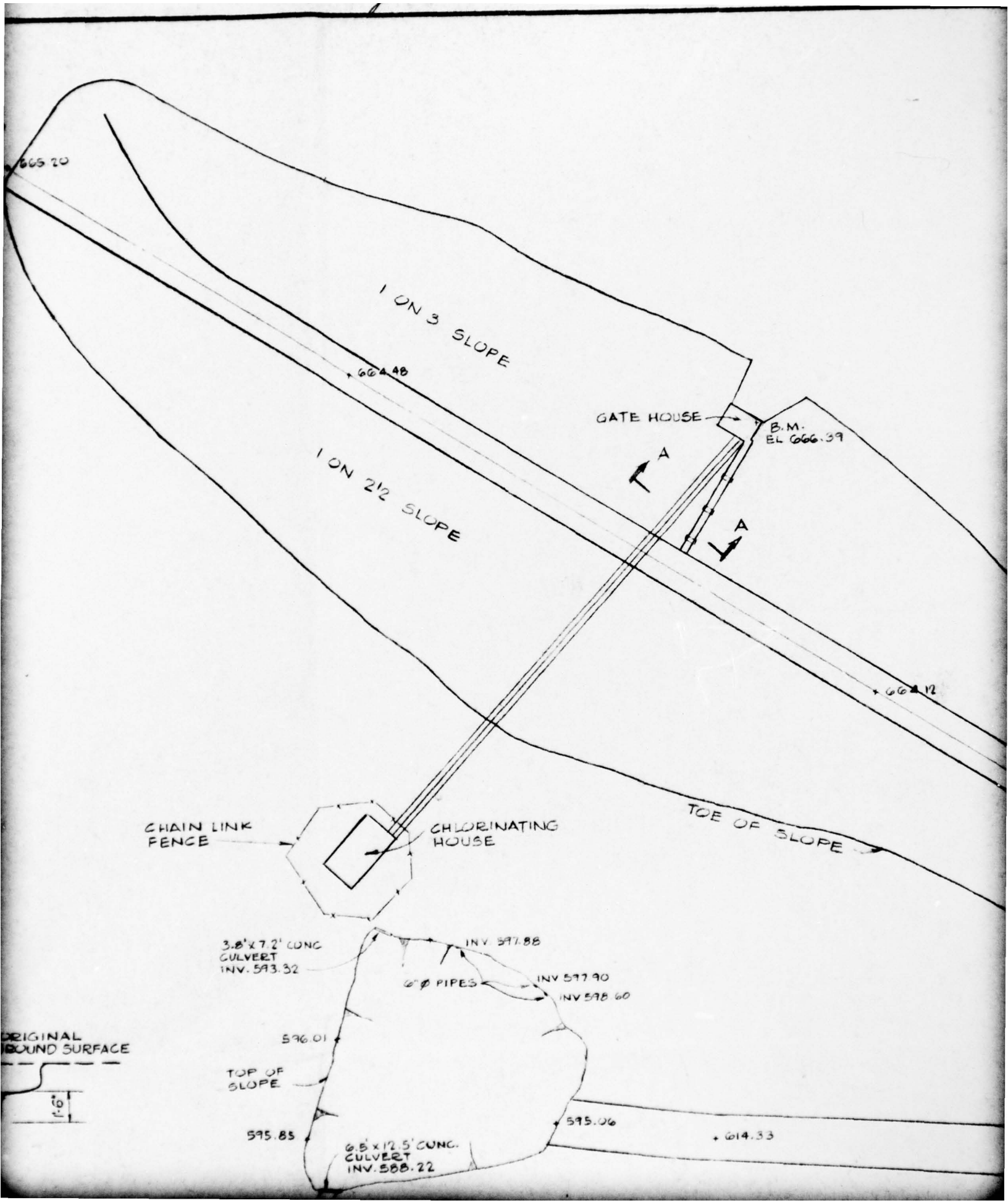
CHAIN
FENCE

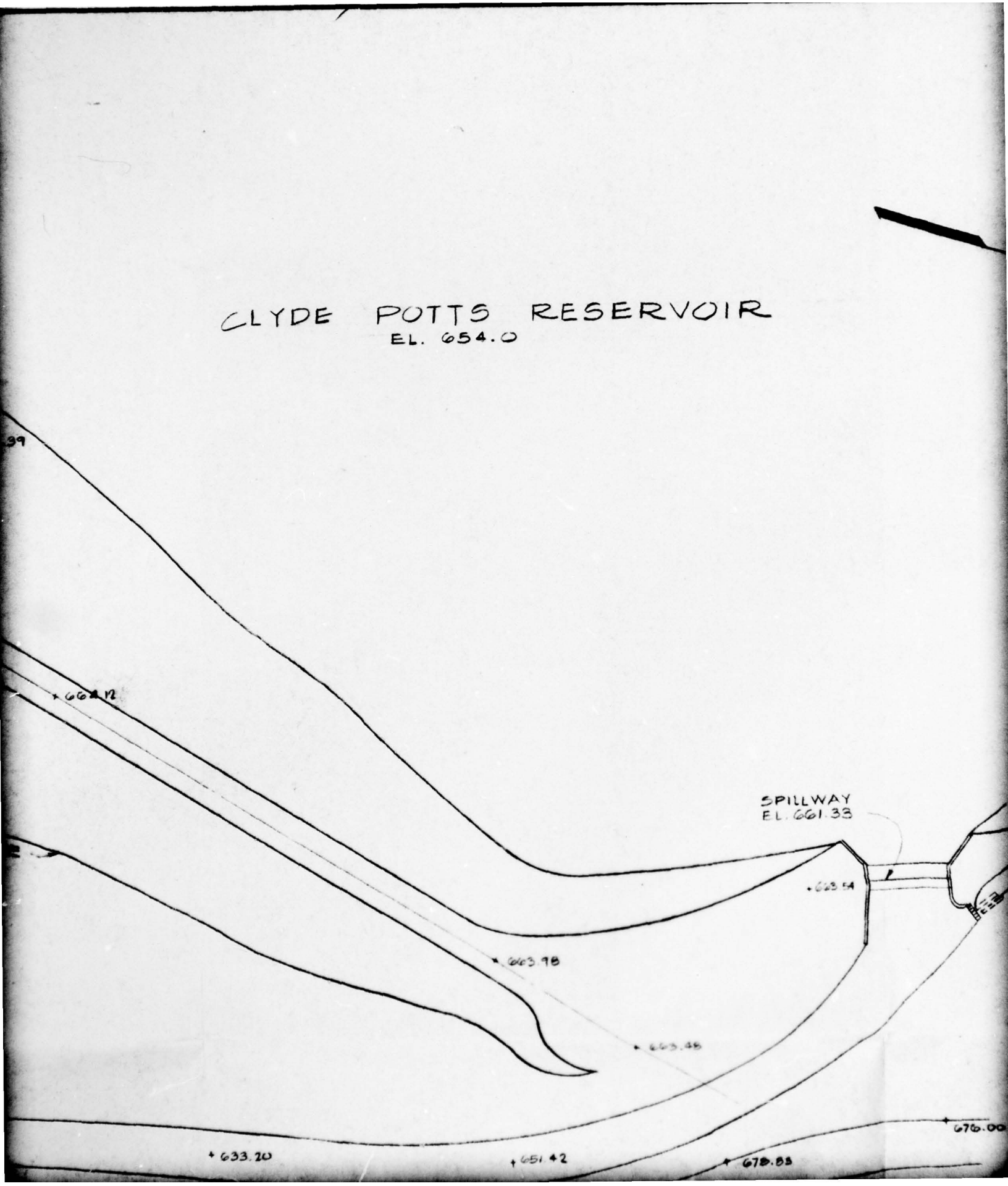


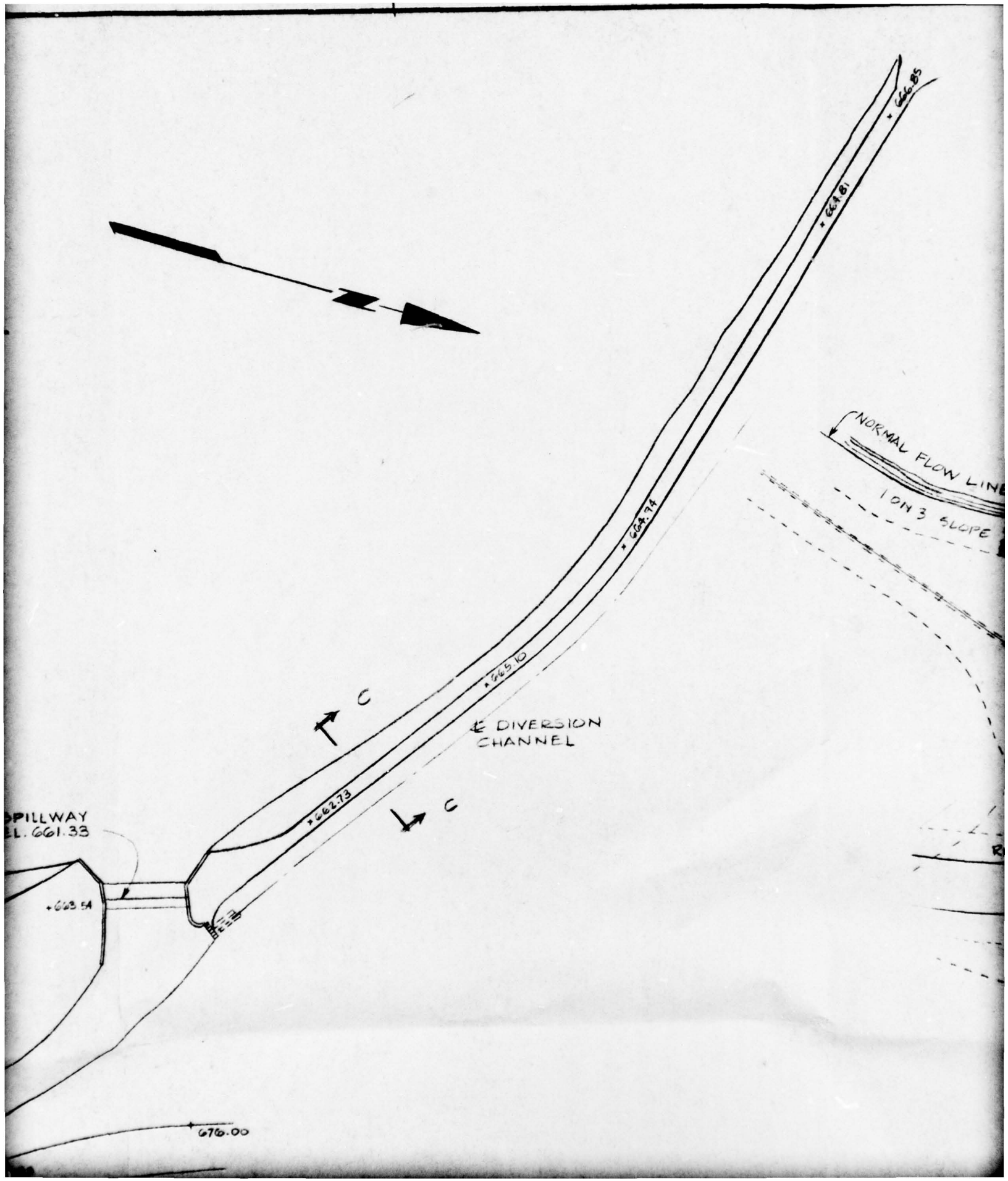
SECTION A-A

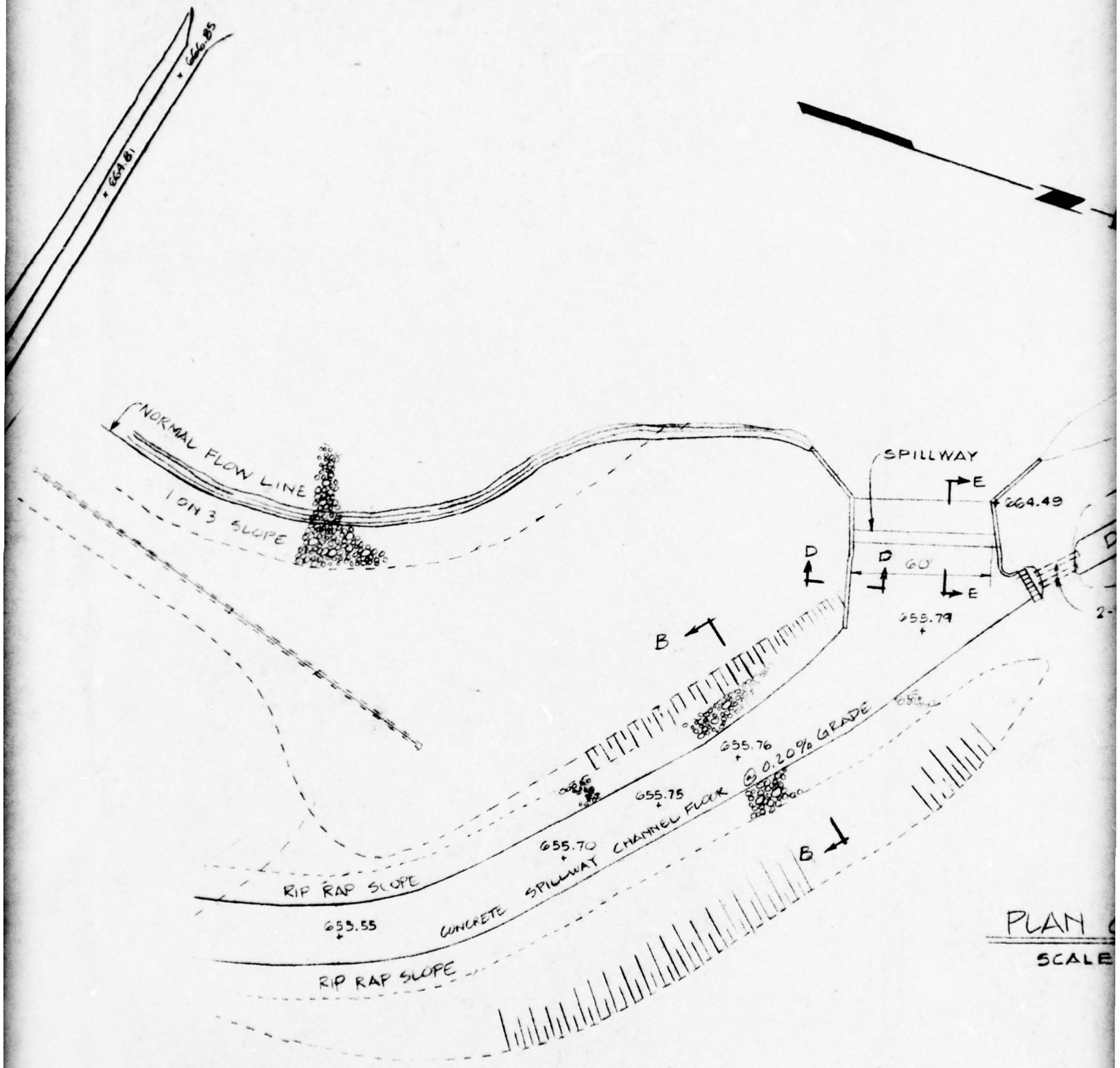
N.T.S.

597.75


665.20
1 ON 3 SLOPE
664.48
GATE HOUSE
B.M.
EL 666.39
A
A
1 ON 2½ SLOPE
666.12
TOE OF SLOPE
CHAIN LINK
FENCE
CHLORINATING
HOUSE
3.8'x7.2' CONC
CULVERT
INV. 593.32
INV. 597.88
6"Ø PIPES
INV 597.90
INV 598.60
596.01
TOP OF
SLOPE
595.85
6.5'x12.5' CONC.
CULVERT
INV. 588.22
595.06
614.33
ORIGINAL
GROUND SURFACE
1.0'


CLYDE POTTS RESERVOIR
EL. 654.0
SPILLWAY
EL. 661.33
+ 663.54
+ 663.98
+ 663.48
+ 633.20
+ 651.42
+ 678.88
676.00

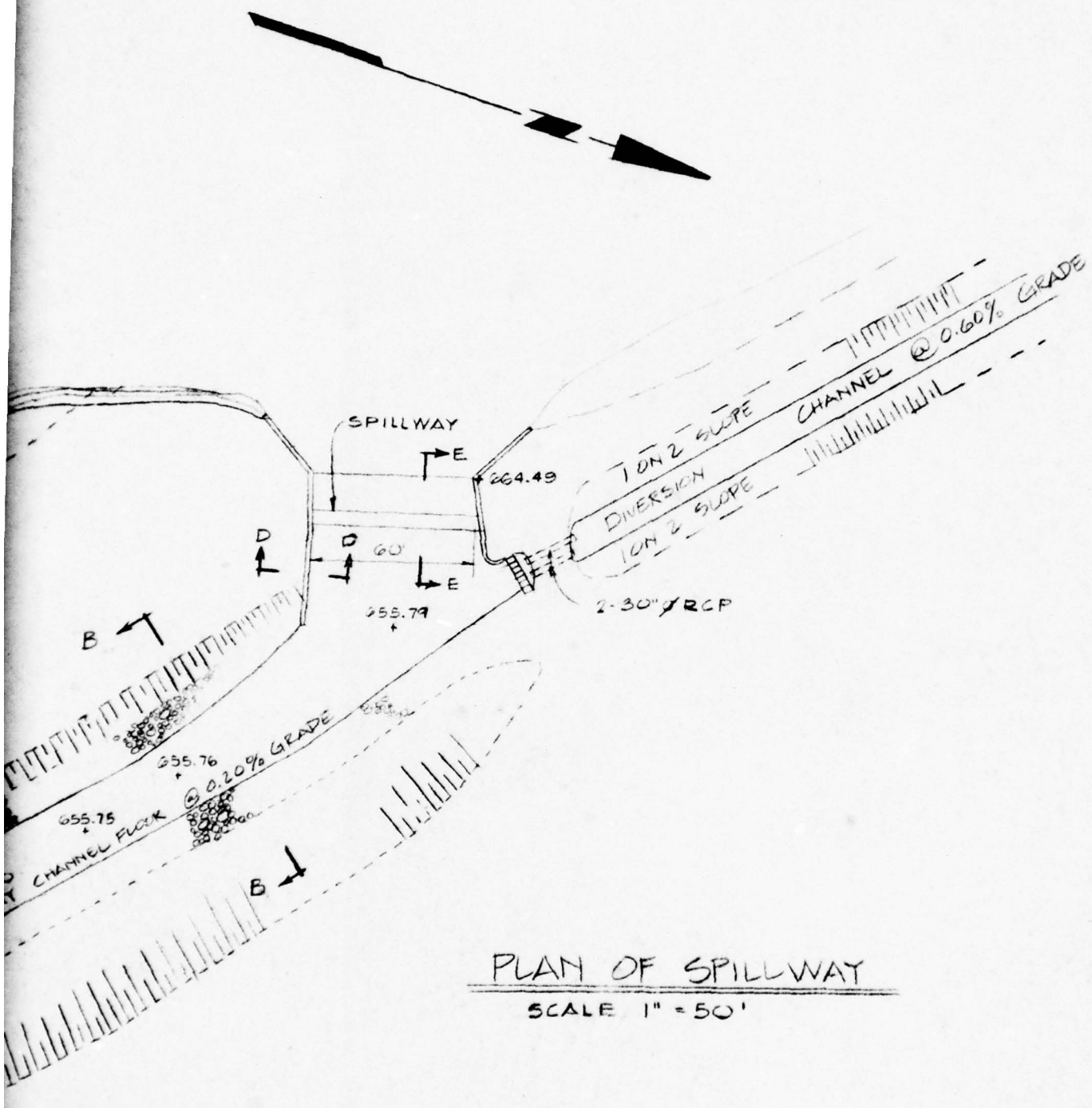

+666.85
+664.81
+664.94
+665.10
+662.73
NORMAL FLOW LINE
1 ON 3 SLOPE
℄ DIVERSION CHANNEL
C
C
PILLWAY
L. 661.33
+663.54
676.00



PLAN

SCALE

EL. 664.49

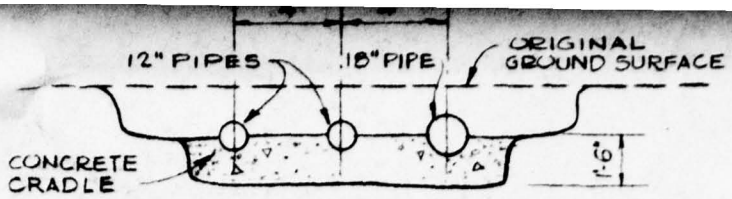


PLAN OF SPILLWAY

SCALE 1" = 50'

EL. 664.49

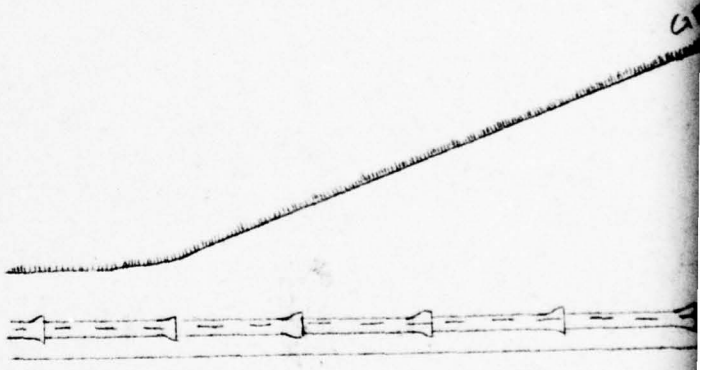
WINGWALL

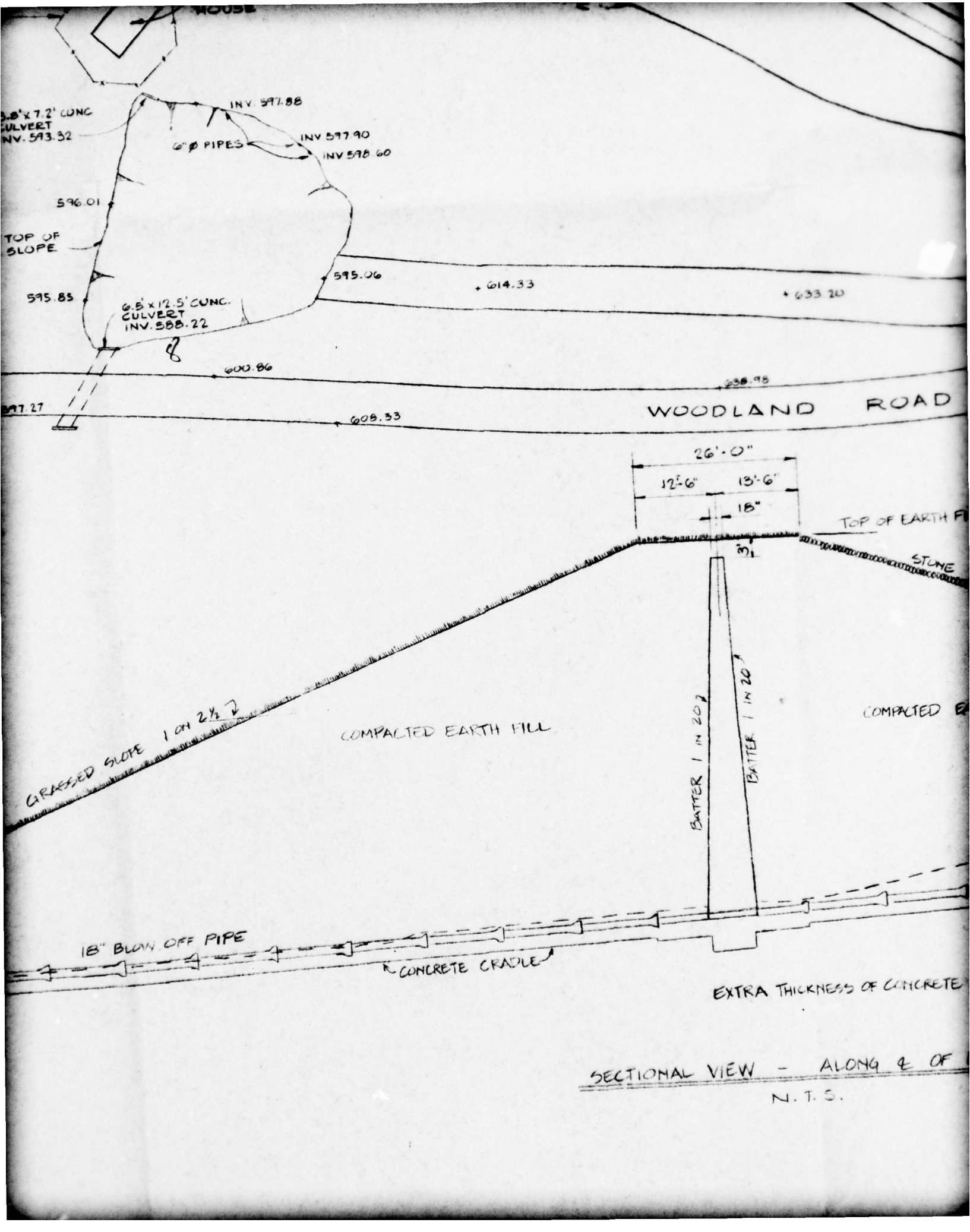


SECTION A-A

N.T.S.

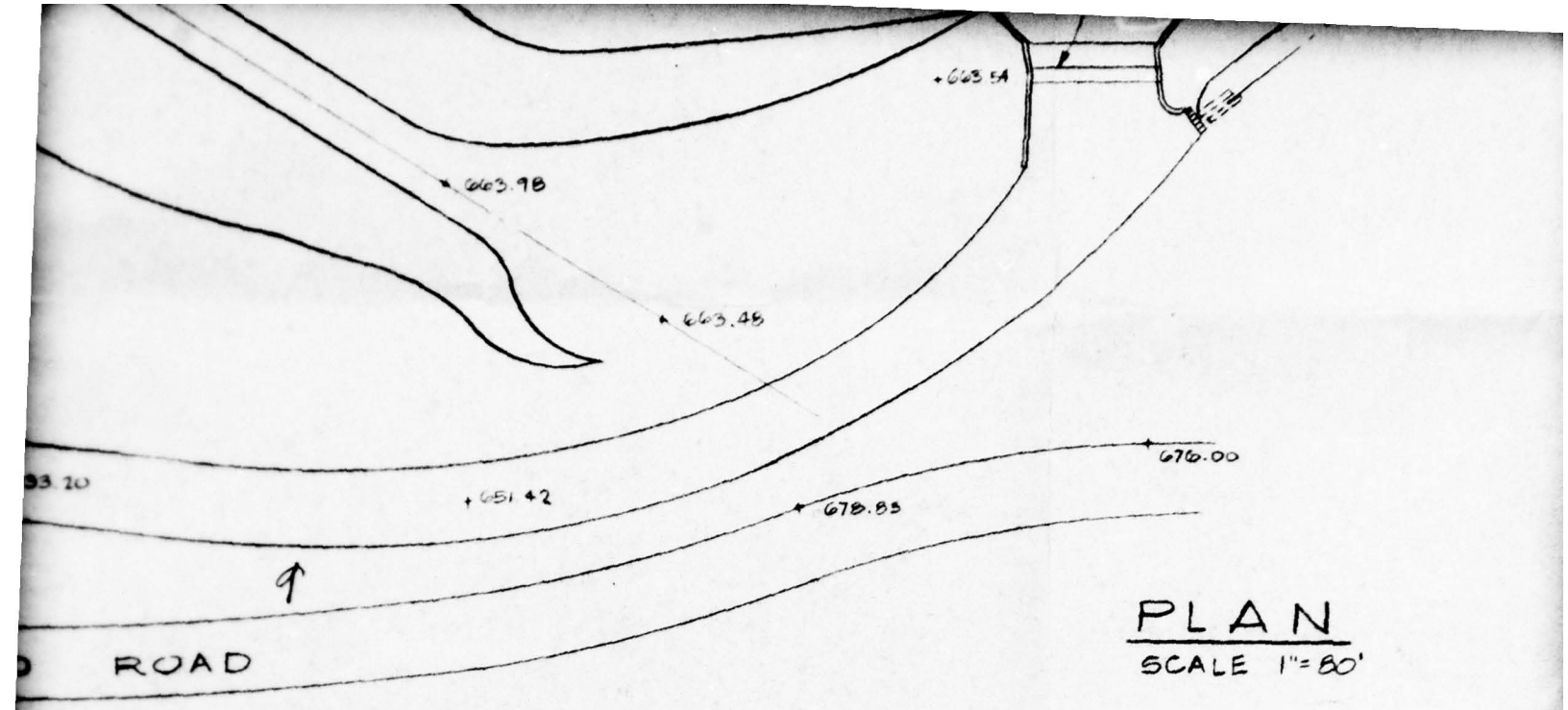
597.75





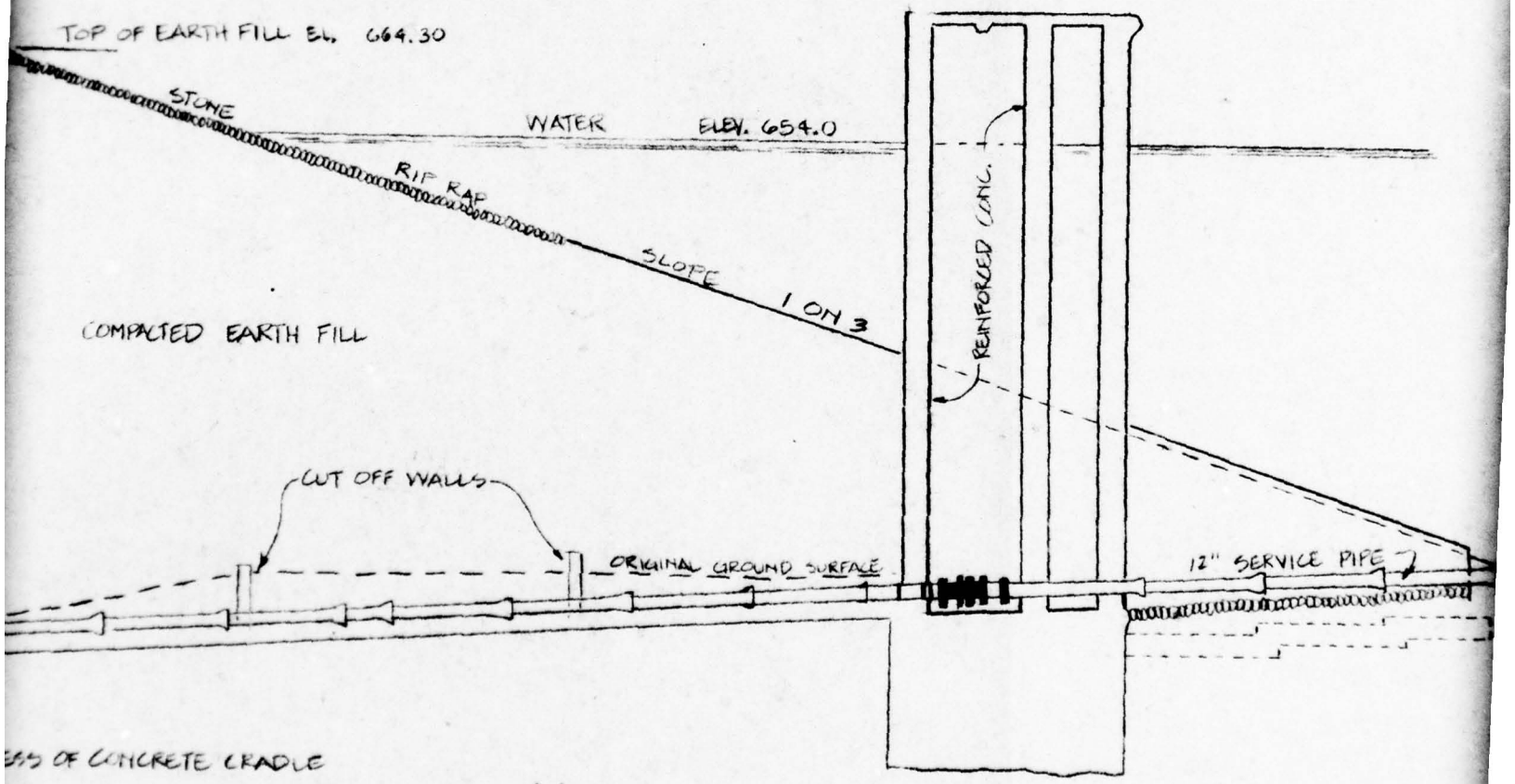
SECTIONAL VIEW - ALONG ℄ OF

N. T. S.



PLAN

SCALE 1"=80'



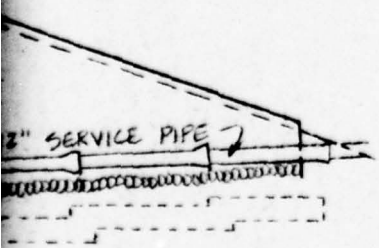
ESS OF CONCRETE CRADLE

LONG ℄ OF 18" BLOWOFF PIPE

A N

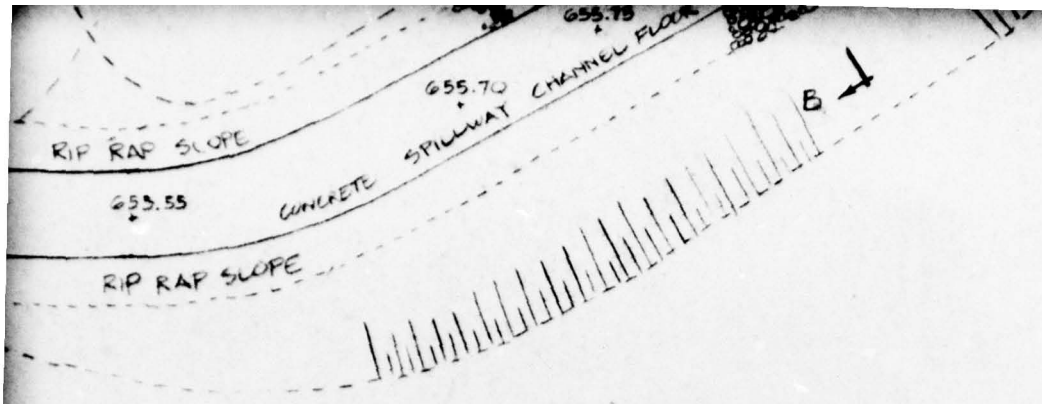
1"= 80'

10



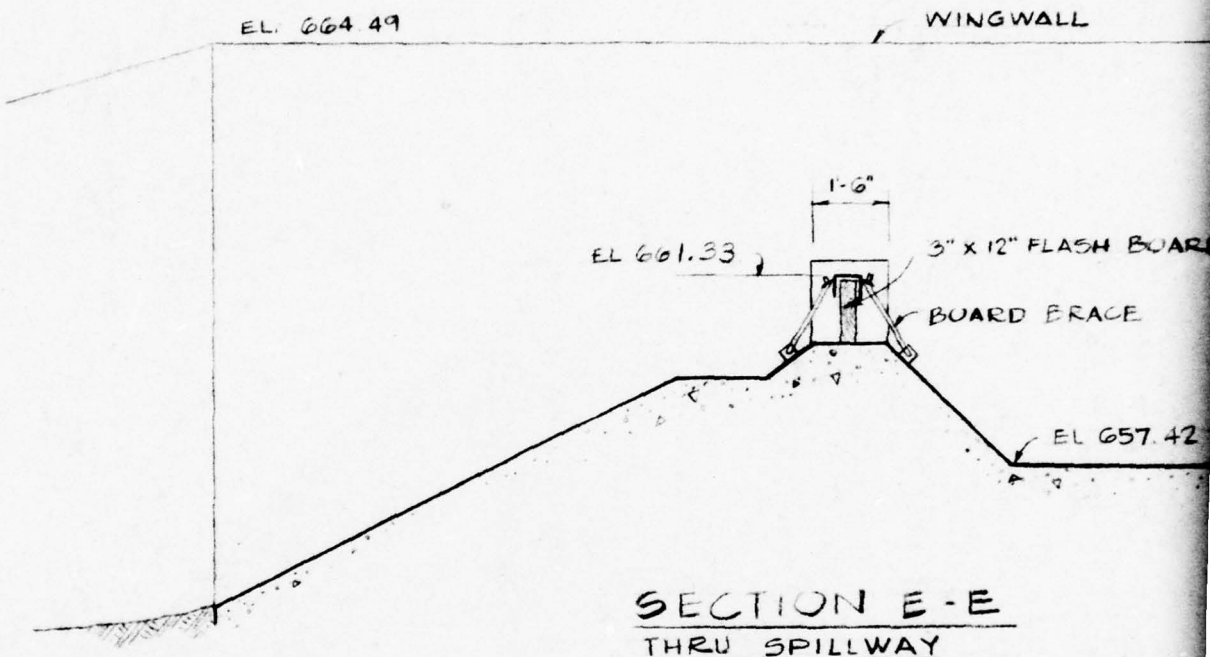
NOTE:

ELEVATIONS SHOWN WERE OBTAINED USING A SURVEYO
AND LEVEL. THEY ARE APPROXIMATE. A BENCH MARK ELEVAT
ON THE SLAB OF THE GATE HOUSE WAS PROVIDED BY MR P WO
T. KILAM ASSOC. INC. INFORMATION SHOWN BELOW GROUND SU
WATER LEVEL ARE INFERRED ON THE BASIS OF THE INFORMATIO
BY N. J. D. E. P..



PLAN OF SPILLWAY

SCALE 1" = 50'

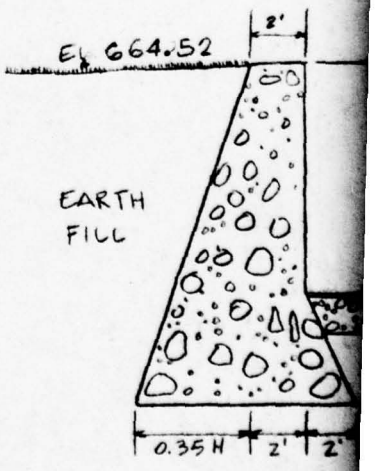


SECTION E-E

THRU SPILLWAY

SCALE: 1" = 3'

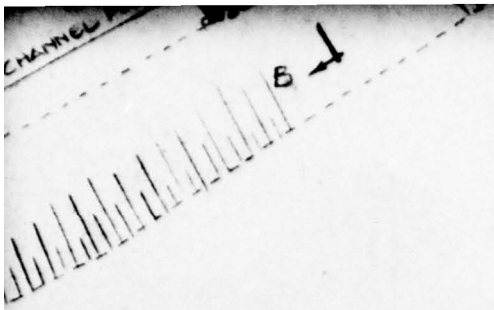
STAINED USING A SURVEYORS TRANSIT
ATE. A BENCHMARK ELEVATION OF 666.39
WAS PROVIDED BY MR P WOOD OF ELSON
ION SHOWN BELOW GROUND SURFACE AND
HE BASIS OF THE INFORMATION PROVIDED



TYPICAL SECTION O
RETAINING WALL

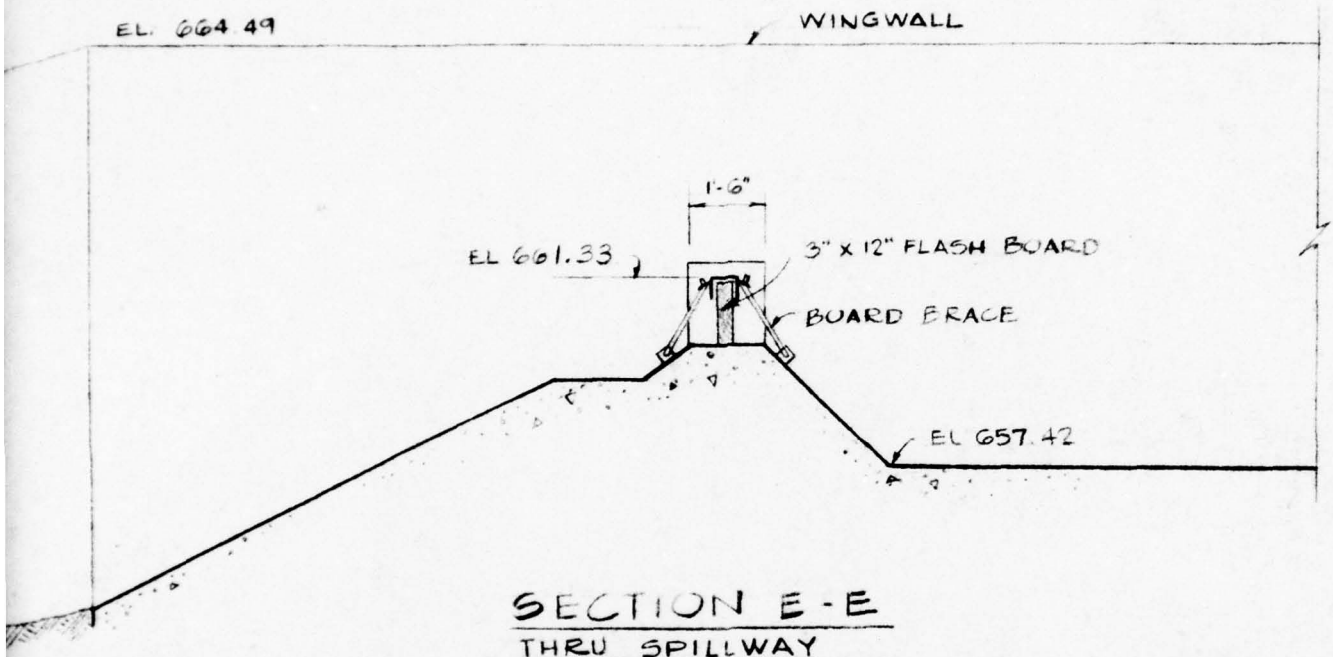
N. T. S.

DATE	DESCRIPTIO



PLAN OF SPILLWAY

SCALE 1" = 50'

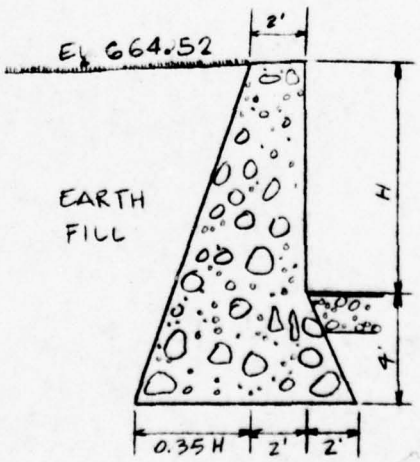


SECTION E-E

THRU SPILLWAY

SCALE: 1" = 3'

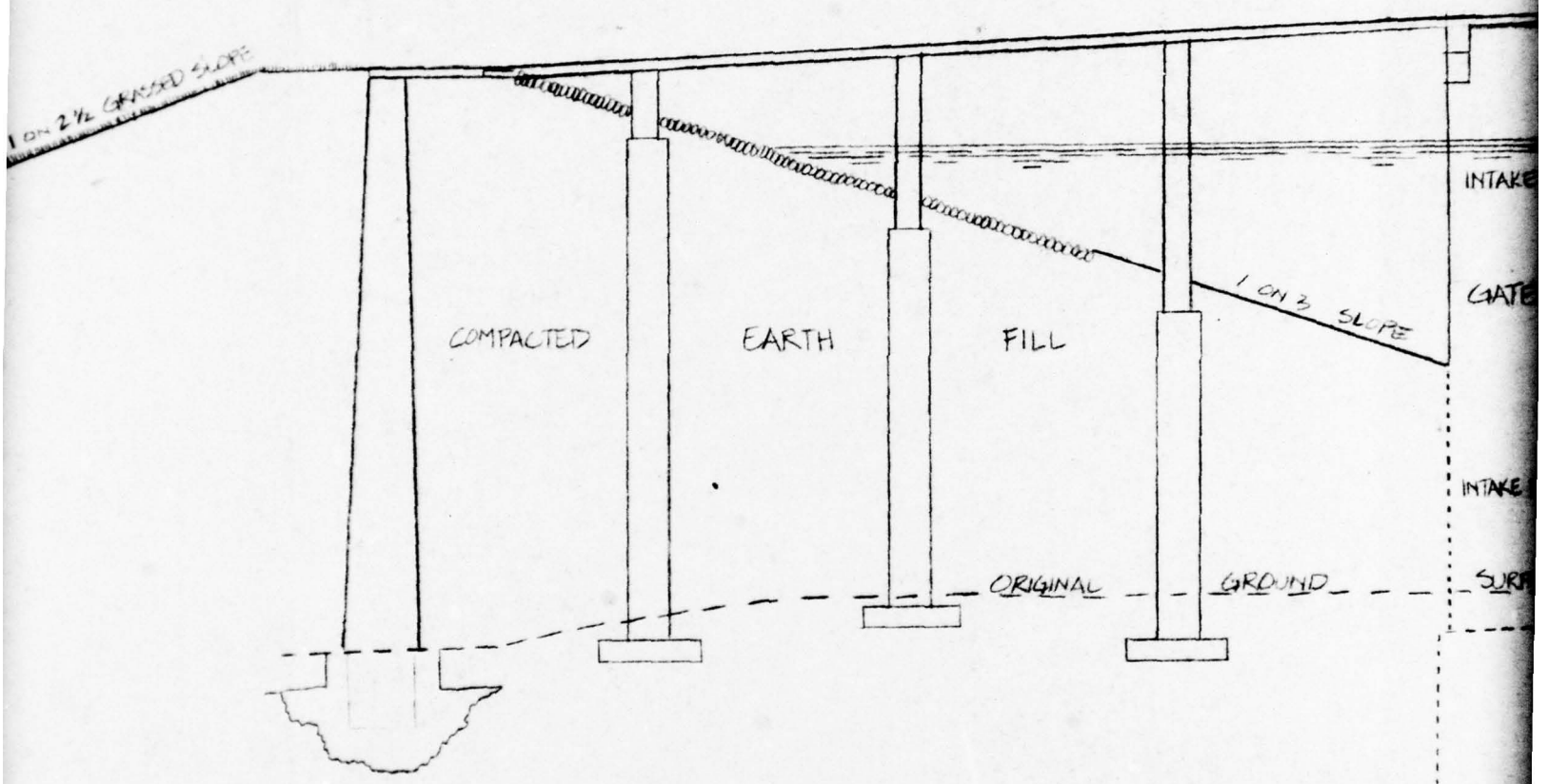
TRANSIT
OF 666.39
OF ELSON
E AND
ROVIDED



TYPICAL SECTION OF CONCRETE RETAINING WALL D-D

N. T. S.

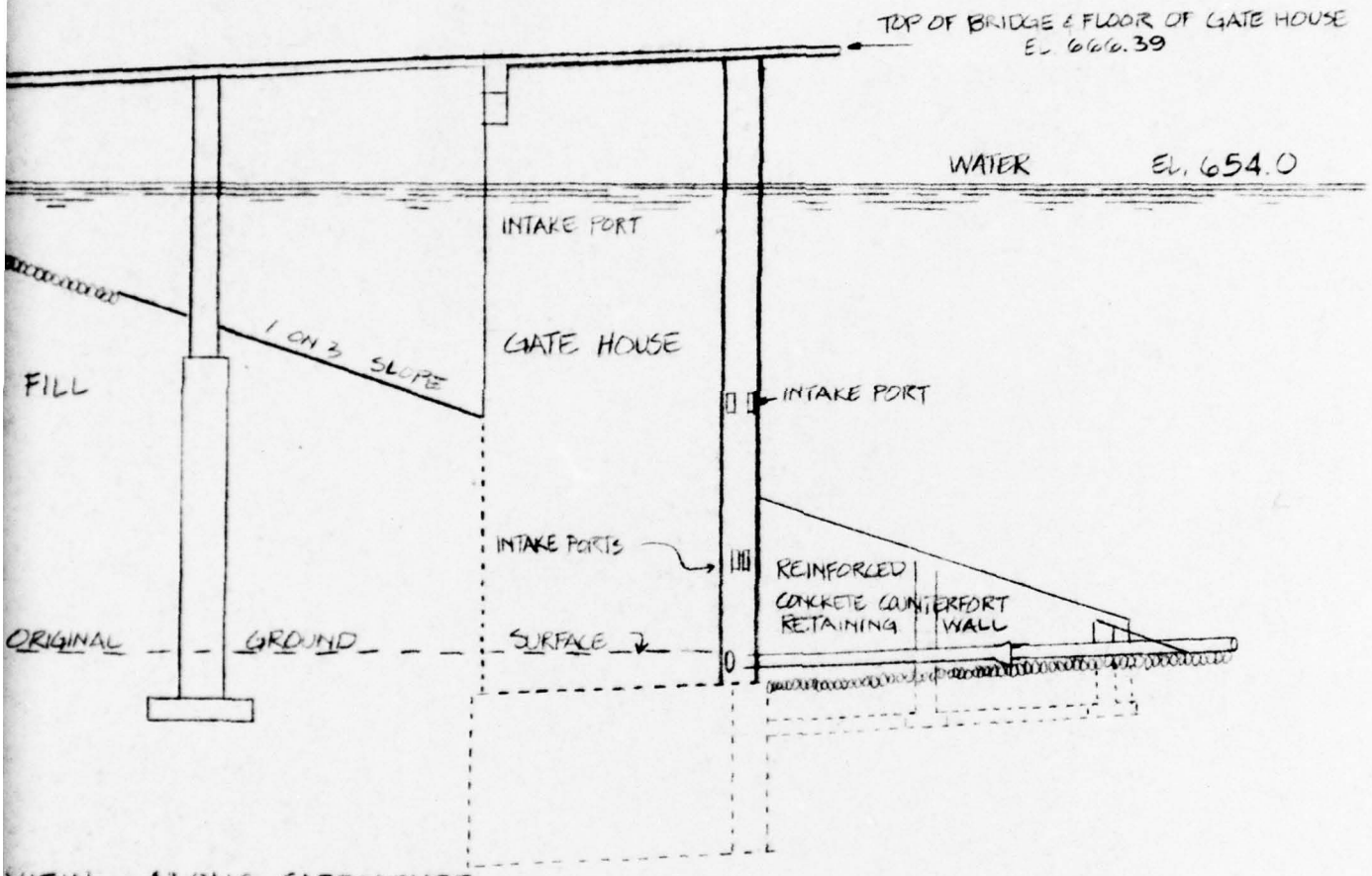
DATE	DESCRIPTION	NO.



SECTIONAL VIEW - ALONG GATEHOUSE

N. T. S.

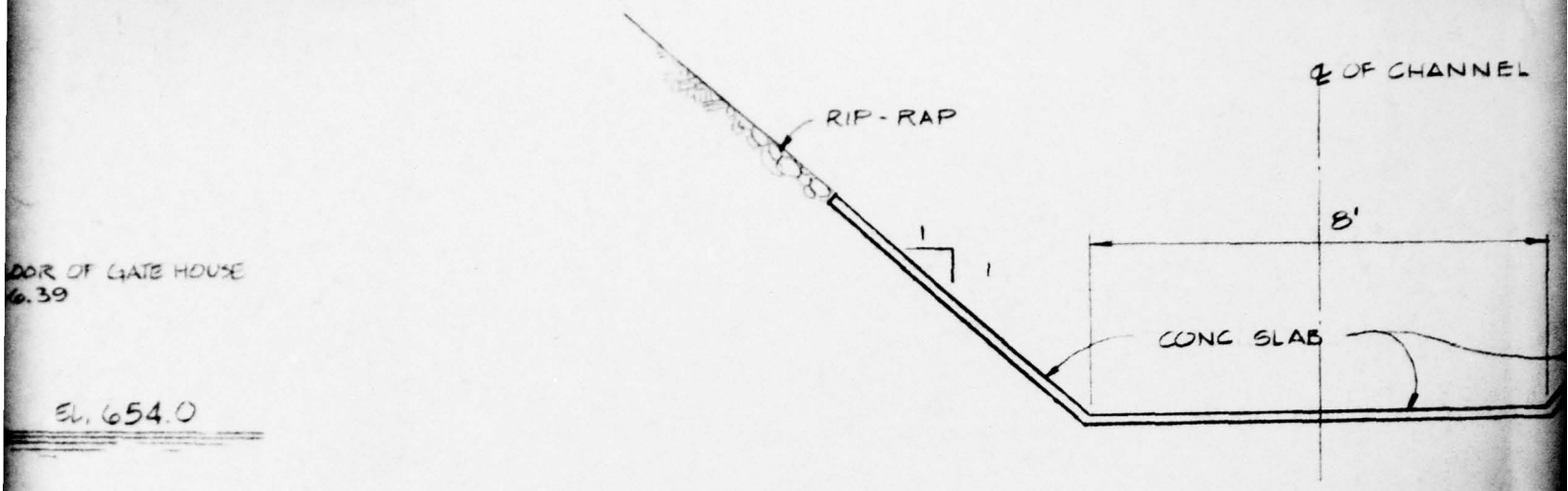
N. T. S.



VIEW - ALONG GATEHOUSE

N. T. S.

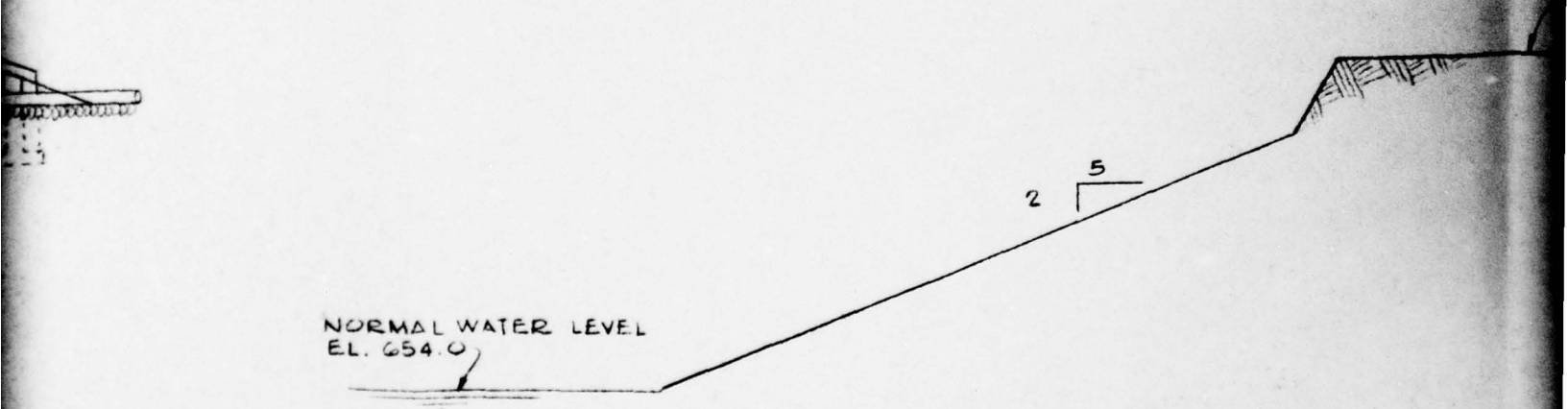
NORMAL WA
EL. 654.0



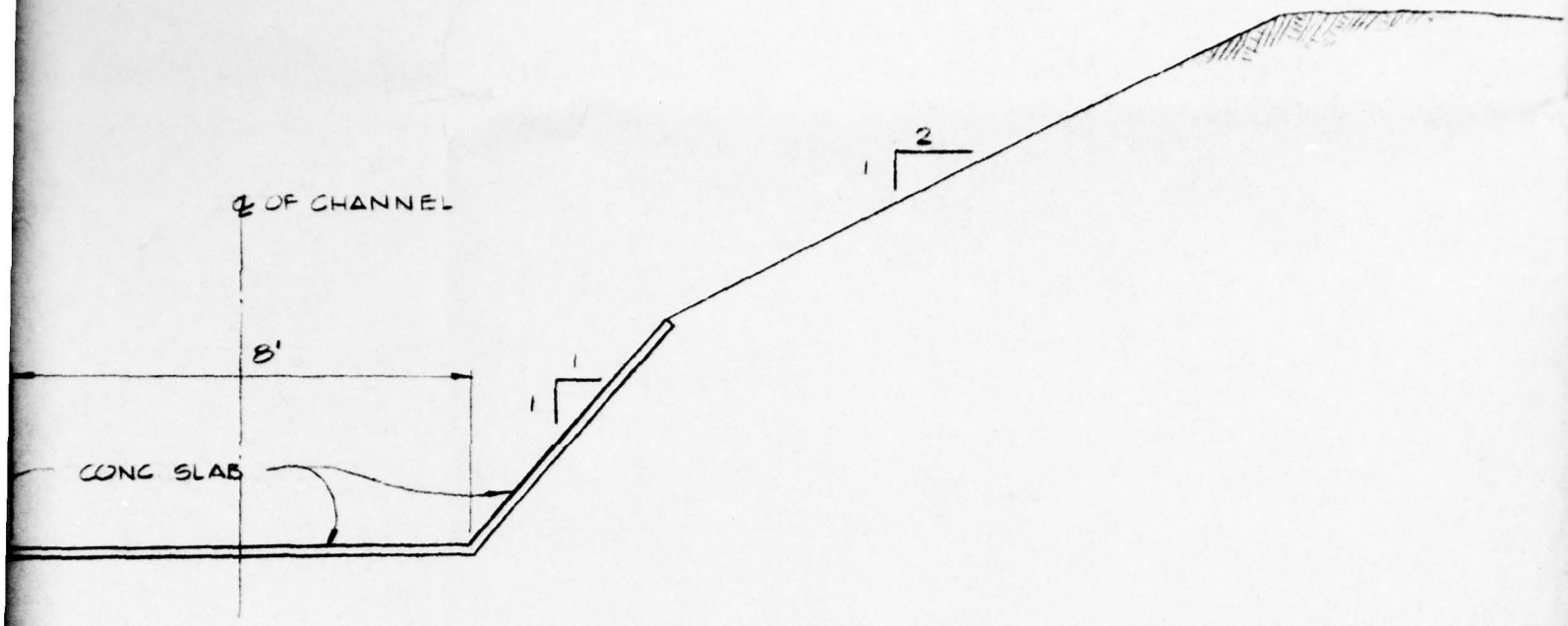
SECTION B-B
SCALE: 1" = 3'

OOR OF GATE HOUSE
6.39

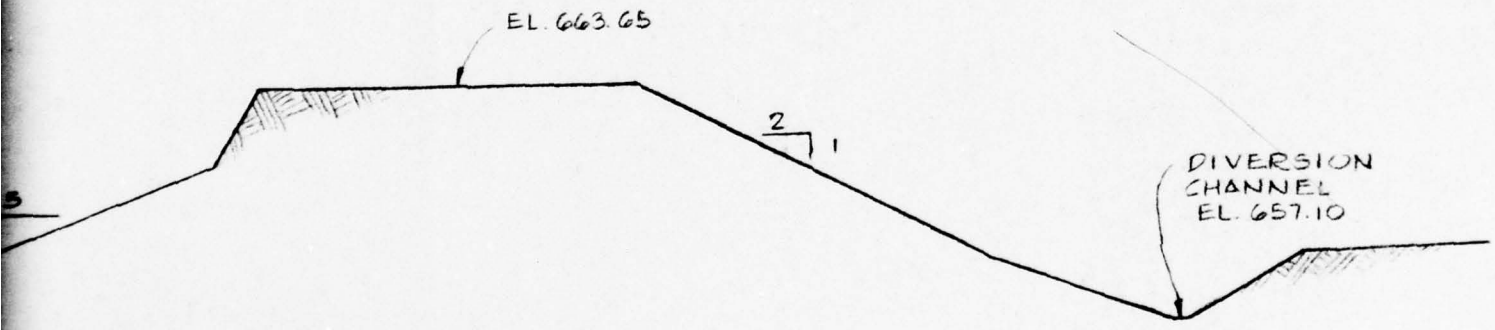
EL. 654.0



SECTION
SCALE 1"



SECTION B-B
SCALE: 1" = 3'



SECTION C-C
SCALE 1" = 5'

DATE	DESCRIPTION	NO.
REVISIONS		

DIVERSION CHANNEL EL. 657.10

LANGAN ENGINEERING ASSOCIATES, INC.

979 Clifton Avenue, Clifton, New Jersey 07013
(201) 777-2970

PROJECT

PHASE I

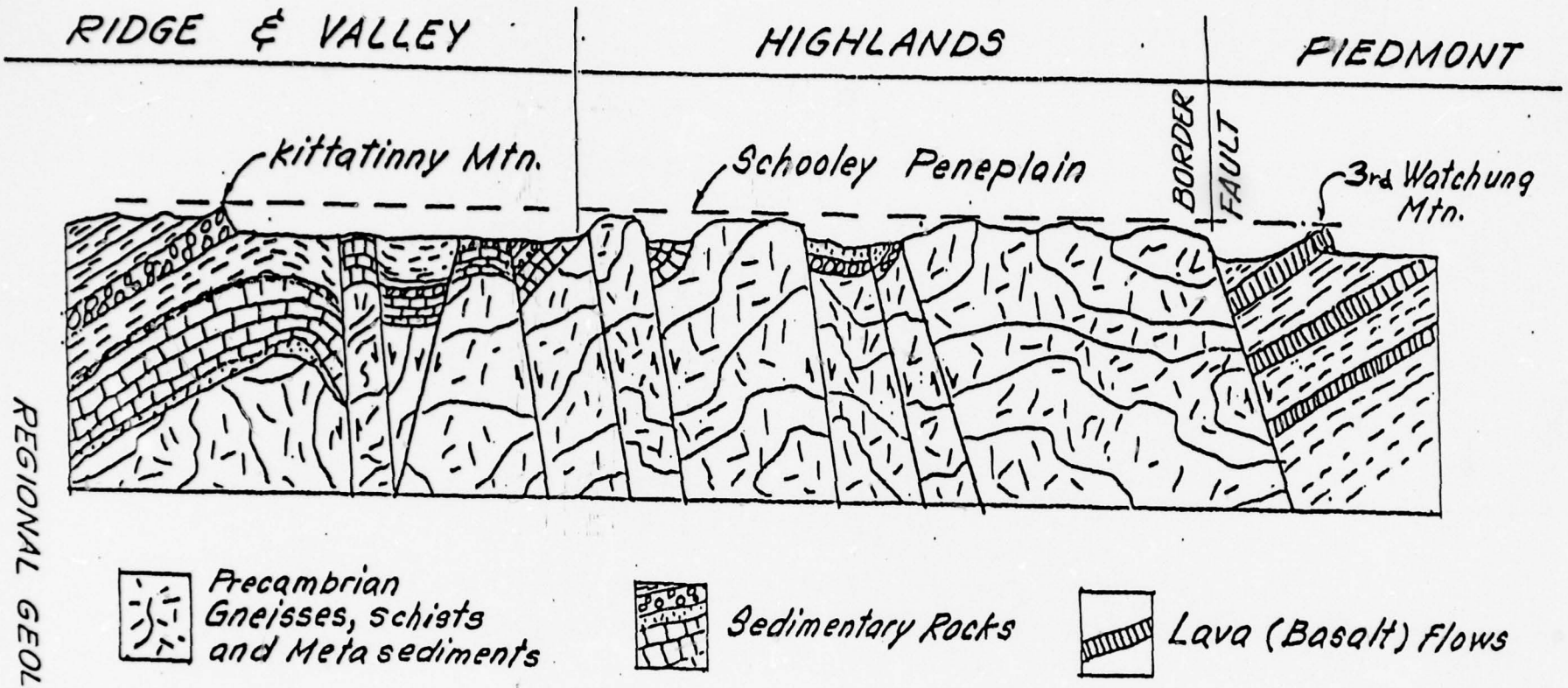
INSPECTION & EVALUATION of NEW JERSEY DAMS

DRAWING TITLE

MORRISTOWN RESERVOIR DAM

DECEMBER 1978
FED. I.D. NO. NJ 00352

JOB NO. J-783B	DRAWING NO. FIG. 2
DATE 18 DEC 1978	
SCALE AS NOTED	
DRN. BY J.R.	
CHKD. BY D.J.L.	



REGIONAL GEOLOGIC FEATURES

Fig. 3

Schematic Cross-section of New Jersey Highlands Physiographic Province (After Wolfe, 1977)

APPENDIX 1

JUNE 1978

INSPECTION REPORT

MORRISTOWN RESERVOIR DAM

Elson T. Killam Associates Inc.

27 Bleeker Street, Millburn, New Jersey 07041
Telephone (201) 379-3400

Environmental and Hydraulic Engineers

Phillip A. Wood, P.E.
Senior Associate

June 26, 1978

State of New Jersey
Department of Environmental Protection
Division of Water Resources
P.O. Box 2809
Trenton, New Jersey 08625

Attention: Mr. John Garofalo,
Senior Engineer
Stream Encroachment Section
Bureau of Flood Plain Management

Re: [redacted]

Gentlemen:

In accordance with the instructions submitted under letter of May 15, 1978, by your office, we have inspected the subject dam. The attached report has been written following the "Guide For Preparation of Report on Condition of Dams" enclosed with your letter.

We understand that the State of New Jersey will be scheduling an additional in-depth study, investigation, and analysis to fully evaluate the safety of this dam.

Respectfully submitted,

ELSON T. KILLAM ASSOCIATES, INC.

Phillip A. Wood, P.E.

PAW:mfw

CONDITION REPORT
CLYDE POTTS RESERVOIR DAM
MENDHAM TOWNSHIP, NEW JERSEY
DAM NO. 151

JUNE, 1978

ELSON T. KILLAM ASSOCIATES, INC.
Environmental and Hydraulic Engineers
Millburn, New Jersey

June 26, 1978

CONDITION REPORT
CLYDE POTTS RESERVOIR DAM
MENDHAM TOWNSHIP, NEW JERSEY
DAM NO. 151

DATE OF INSPECTION: JUNE 15, 1978

NAME OF DAM: Clyde Potts Reservoir (Brookside Reservoir)

OWNER'S NAME: Southeast Morris County Municipal Utilities Authority

ADDRESS: 101 Western Avenue, Morristown, New Jersey 07960

General Dam

The subject dam is a gravity earth embankment design with a concrete core wall. The downstream embankment is grassed over, clear of any large shrubs or trees. The top of the dam appears to be level and in good condition with no evidence or report of wash out. There are several locations near the toe of the dam where the toe drains appear to be inoperable, reportedly due to plugging and there are resulting wet areas. There is evidence of groundhog activity in the downstream embankment. The upstream face of the dam appears to be in good condition with only very minor slippage of the riprap protection for the main dam. The secondary dike on the north side of the dam does not have riprap protection.

In general, the dam appears to be in good condition.

Spillway and Outlet Flume

There are several boils visible at the downstream end of the spillway apron and adjacent to the retaining wall of the spillway,

indicating leakage under the spillway apron. The timber flashboards on the concrete spillway section have deteriorated to some extent and are leaking. The concrete lined outlet flume, which is several hundred feet long, has growth in the form of grass, brush and small trees (1/2" Ø). In addition, the lower section appears to have had its foundations washed away and has broken up to some extent and has settled.

The swale to the north of the secondary dike has become partially overgown and should be grubbed out so that clear flow can occur.

An existing temporary timber weir on the upstream section of the concrete culvert under Woodland Road, could restrict the spillway storm overflows.

Mechanical Equipment

At least one of the sluice gates controlling the intake level is reported to be inoperable and there are indications that the outlet screens from the inlet structure are in need of replacement. In addition, the ladders within the structure require repair and/or replacement so that access to this relatively deep structure can be made safely. Hand-rails which were originally installed on the bridge from the top of the dam to the inlet structure are missing and there is no railing around the top of the inlet structure itself. New hinges have been recently installed on the hatches in the inlet structure.

Miscellaneous

According to the owners and operators and available records, the dam as it presently exists has never been over topped and the condition

of the roadway on top of the dam appears to confirm this.

Conclusions

I certify that the above dam was personally inspected by me and Phillip A. Wood, P.E. and was found to be in good condition.

I recommend that the following repairs be made immediately;

UNDER 1. Seal the area around the upstream apron of the spillway to prevent leakage under the spillway.

UNDER 2. Riprap the face of the secondary dike along its entire length.

3. Grub out and remove growth from the swale behind the secondary dike and the joints within the outlet flume.

UNDER 4. Repair or replace the damaged sections of the outlet flume lining.

Presently being done 5. Clean, repair and/or replace the toe drains to prevent the backup of water and to provide clear drainage for the toe.

6. Eradicate the groundhog population.

UNDER 7. Repair the inoperable sluice gate in the intake structure and service the other sluice gates and valves in the structure.

To be Replaced 8. Repair and/or replace ladders into the intake structure.

9. Install railings around the bridge to the intake structure and the intake structure itself and keep locks on all hatches. As an alternative, install a chain link gate at the dam end of the bridge to control access to the structure.

10. Replace the deteriorated flash boards and provide properly designed break-away ties.
11. Replace fish screens in the inlet structure.
12. Remove the existing temporary timber weir on the upstream section of the concrete culvert under Woodland Road.

This Inspection Report on Condition of Dam 151 (Clyde Potts Reservoir Dam) is based on a visual inspection and evaluation of the general condition of the dam and appurtenant structures including recommended repairs. Our report includes results of information obtained by interviews of Authority Personnel. This report does not imply a guarantee or assurance that the dam is "safe", under any situation.

Under this phase of inspection and reporting no evaluation of hydraulic and hyrologic features nor structural and seismic stability assessments have been made or implied by us. It is our understanding that the State of New Jersey - Division of Water Resources, under a National Program, is scheduling additional in-depth studies, investigations and analyses to evaluate the safety of this dam.

Inspected By:

Frank A. Filippone

FRANK A. FILIPPONE
of
ELSON T. KILLAM ASSOCIATES, INC.
27 Bleeker Street
Millburn, New Jersey 07041
(201) 379-3400

N.J. P.E. No.5689

DATE June 20, 1978

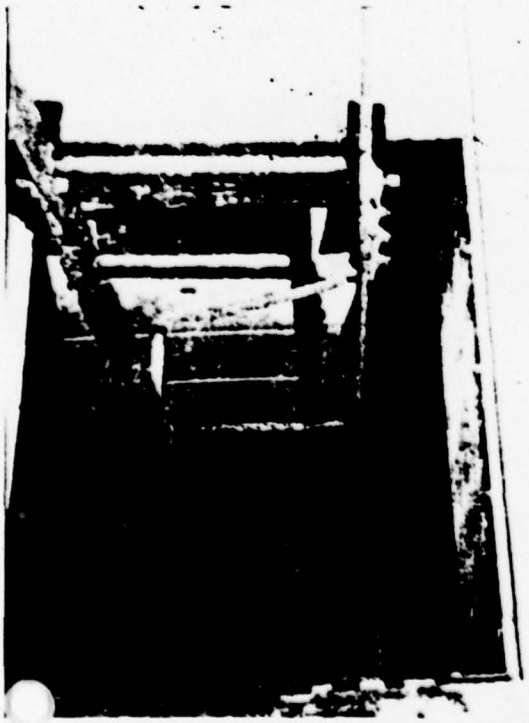
VIEW OF UPSTREAM FACE OF DAM
LOOKING SOUTH FROM INTAKE
STRUCTURE

VIEW OF UPSTREAM FACE OF DAM
LOOKING NORTH FROM INTAKE
STRUCTURE

VIEW OF DOWNSTREAM EMBANKMENT

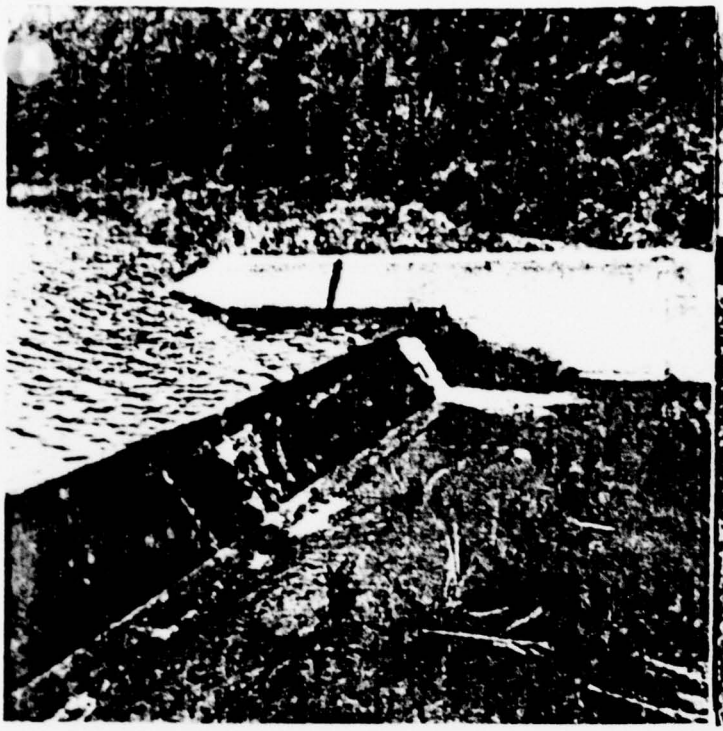
VIEW OF INTAKE STRUCTURE AND WALKWAY LOOKING NORTH

VIEW OF TOP OF INTAKE STRUCTURE LOOKING WEST



ACCESS HATCH SHOWING LADDER

TOP OF ACCESS HATCHES

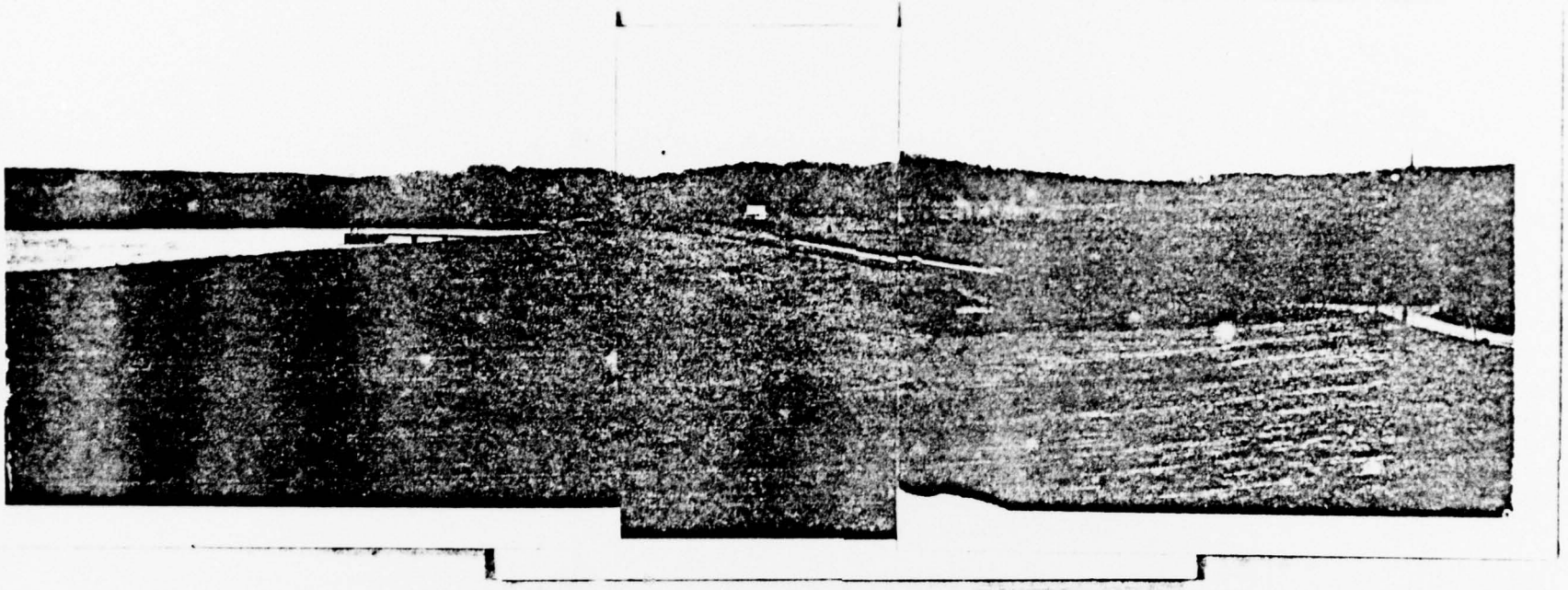


SPILLWAY LOOKING NORTH

SWALE BEHIND SECONDARY DIKE

PORTION OF SPILLWAY FLUME
LOOKING EAST

PORTION OF SPILLWAY FLUME
LOOKING WEST



PANORAMIC VIEW OF DOWNSTREAM
FACE OF CLYDE POTTS RESERVOIR DAM

APPENDIX 2

CHECK LIST

VISUAL INSPECTION

MORRISTOWN RESERVOIR DAM

CHECK LIST
VISUAL INSPECTION

Phase I

NAME DAM Morristown Reservoir COUNTY Morris STATE New Jersey COORDINATORS N.J.D.E.P.

DATE(s) INSPECTION See Below WEATHER Cloudy TEMPERATURE 33°F - 45°F

POOL ELEVATION AT TIME OF INSPECTION 634* M.S.L. TAILWATER AT TIME OF INSPECTION 580** M.S.L.

* From elevation provided by owner's engineer.
** Est. from USGS Topo Map

INSPECTION PERSONNEL:

D. Leary	11/22/78	P. Yu	12/18/78	J. Gurkovich	12/18/78
J. Richards	11/22/78 12/5/78	J. Rizzo	12/18/78		
P. Wood	11/22/78				

Senior Associate, Elson T. Killam Assoc., Inc.

James Richards RECORDER

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	3 ft x 5 ft x 12 in. board across bottom of culvert under Woodland Road.	Board should be removed.
SLOPES	Appear Satisfactory	
APPROXIMATE NO. OF HOMES AND POPULATION DOWNSTREAM	More than 100 homes, Town of Brookside, USGS Topo Map. Population est. greater than 300.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None Observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None OBSERVED	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	3' x 2' x 6" Topsoil slough downstream face.	Sloughed area should be repaired.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical depressions 2" to 6" deep, 3 ft wide, 5 to 8 ft in length.	Depressed areas should be suitably filled.
RIPRAP FAILURES	None Observed.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SECONDARY DIKE	Several areas of upstream face eroded.	Slope should be properly protected.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	At the junction of spillway & the dam, erosion of 2" to 4" deep.	Eroded areas should be suitably filled.
ANY NOTICEABLE SEEPAGE	Water seeping into chlorination house under floor through crack. Two seeps located downstream of dam.	Seepage should be controlled. Origin should be located and controlled.
STAFF GAGE AND RECORDER	Recorder operating.	
DRAINS	Main drain blow off partially open. discharge est. 40 gpm.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Several small cracks.	Cracks should be repaired.
INTAKE STRUCTURE	None Observed.	
OUTLET STRUCTURE	None Observed.	
OUTLET CHANNEL	High weeds and rock fountain appears satisfactory.	
EMERGENCY GATE	None	Alarm system with automatic emergency gate should be installed.

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARK OR RECOMMENDATIONS
SLOPES	Appears Satisfactory	Earth slopes from 1 V. to 4 H. on 60% to 1 V. to 2 H. on 40% of the sides.
SEDIMENTATION	Appears Satisfactory	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Appears Satisfactory	Galvanized guide restraints and 4" x 12" wooden flashboards.
APPROACH CHANNEL	Appears Satisfactory	
DISCHARGE CHANNEL	Voids below spillway apron and channel. Concrete slab bottom and sides uplifted 4 in. - 6 in. Sedimentation and plant growth in channel.	Concrete slab and subgrade repairs should be made. Sedimentation and plant growth should be removed.
BRIDGE AND PIERS	Bridge for Woodland Road crosses spillway discharge channel. Appears Satisfactory.	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	Survey marker on left upstream corner of gated spillway.	
OBSERVATION WELLS	Two wells through sill of gated spillway. Appear Satisfactory.	
WEIRS	None OBSERVED.	
PIEZOMETERS	None Observed.	
OTHER	Valves in chlorination house rusted on outside of valves and pipes.	

GATED SPILLWAY

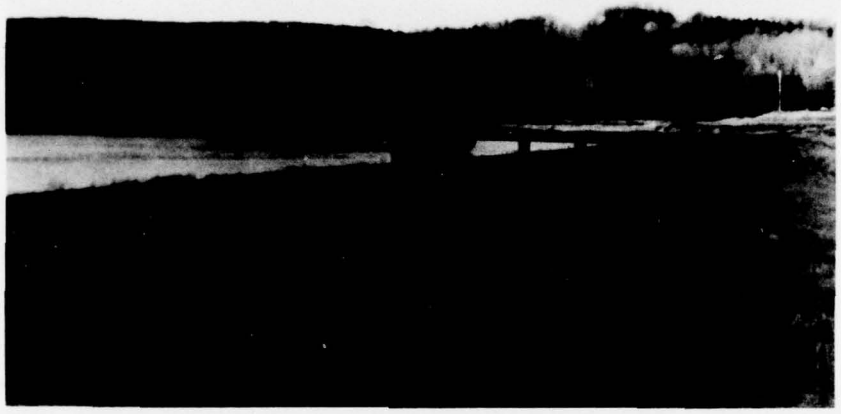
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	1.5 ft traingular corner section of concrete cracked on the right downstream corner connection of spillway and walkway.	Cracked concrete should be repaired.
APPROACH CHANNEL	Appears Satisfactory.	
DISCHARGE CHANNEL	High brush and weeds cover discharge channel.	High brush and weeds should be grubbed.
BRIDGE AND PIERS	Concrete footbridge embankment joint open. Concrete piers and top cracked.	Joint should be suitably filled. Cracked concrete should be repaired.
GATES AND OPERATION EQUIPMENT	6 Rodney Hunt operators. Two not operable (high opening), two questionable (mid-height), and two lower gates work*.	Repair/replace non-operating gates and have manufacturer check all gates if possible. Also, operator stem used to hold gatehouse door down should be removed and replaced with proper locks.

* Information provided by Owner's Engineer.

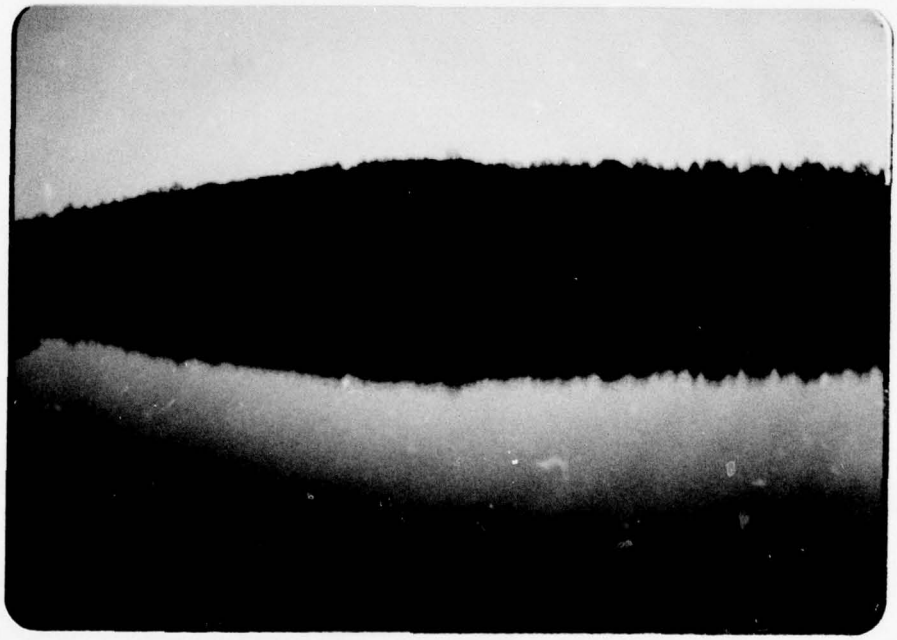
APPENDIX 3

PHOTOGRAPHS

MORRISTOWN RESERVOIR DAM



View of embankment. Looking upstream. 5 December 1978



Rip rapped upstream face. 5 December 1978

Crest of earthfill dam. Note sags in crest.

5 December 1978

Rip rap on upstream face.

5 December 1978

Spalled and cracked concrete on spillway and piers.

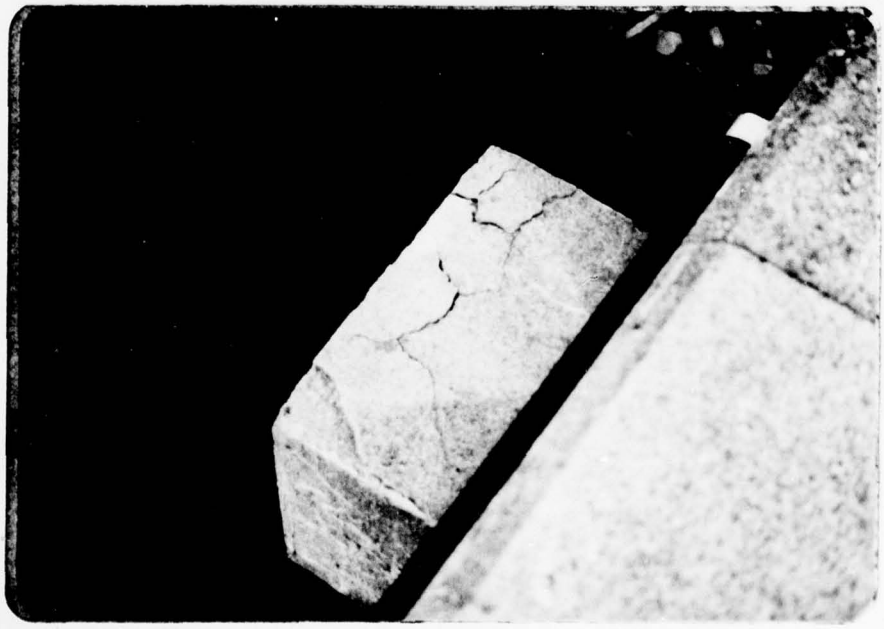
5 December 1978

Operators top of spillway.
Note: access hatch inaccessable due to stem holding lid down.

5 December 1978

Structural crack at footbridge/
spillway connection.

5 December 1978



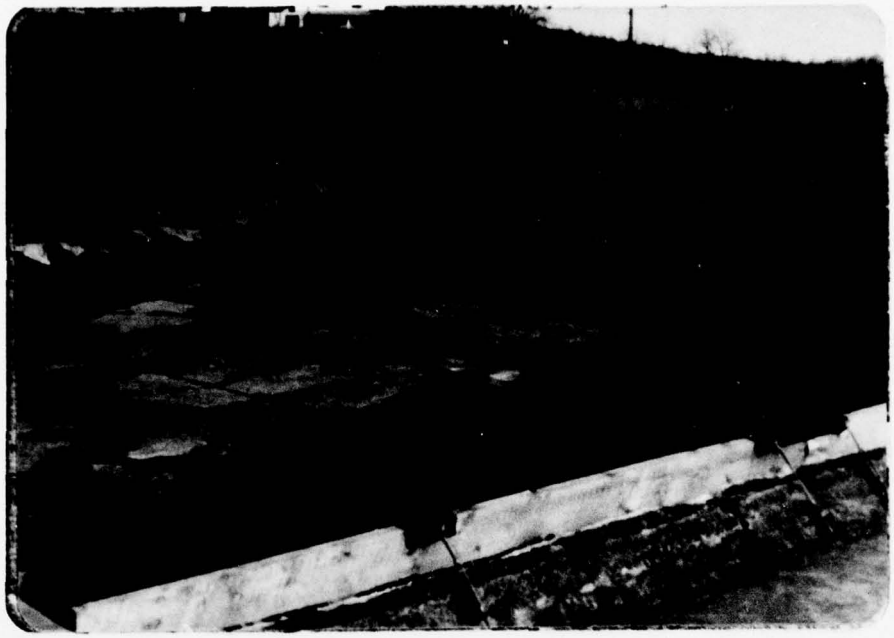
Pier supporting footbridge.
Note: deteriorated concrete.

5 December 1978

Face of secondary dike. Note absence of slope protection. 5 December 1978

Flashboard at top of spillway crest.

5 December 1978

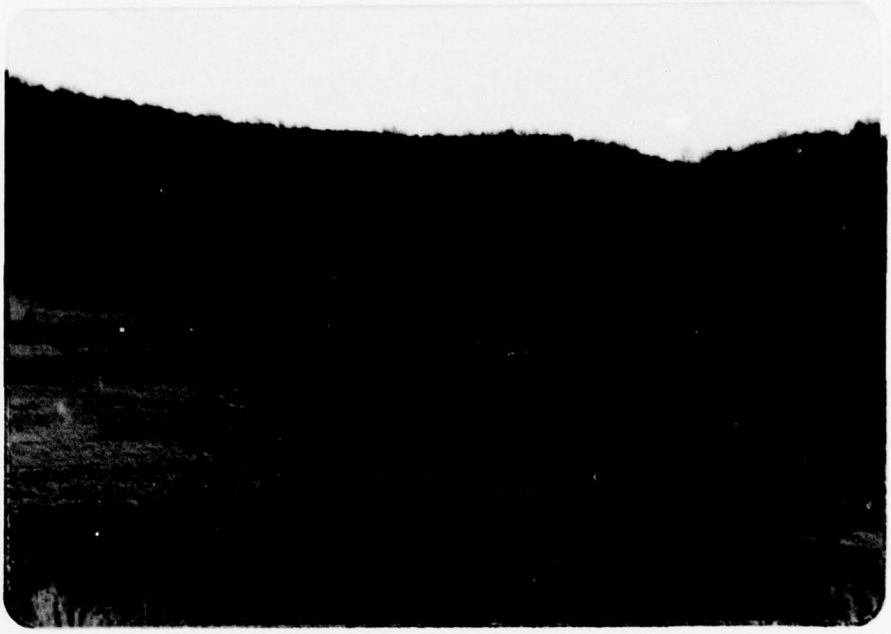


Spillway apron concrete uplifted, spalled and cracked. Side walls also cracked. 5 December 1978

Drainage pipes. Water running through pipes into spillway flume. 5 December 1978

Water in outlet flume. Note: discontinuous flume concrete with water under flume. 5 December 1978

Spillway flume concrete. 5 December 1978



Overgrown stilling pond downstream of dam. Pond discharges under roadway. 5 December 1978

Board across culvert under roadway. 5 December 1978

APPENDIX 4

HYDROLOGIC COMPUTATIONS

MORRISTOWN RESERVOIR DAM

LANGAN ENGINEERING ASSOCIATES, INC.

HYDROLOGIC COMPUTATIONS
MORRISTOWN RESERVOIR DAM

A. Location — Morris County, N.J.

B. Drainage Basin — 2.15 sq. mi

Area of Lake — 36.7 Acres

C. Classification — size – intermediate, heigh >40' & <100'

Hazard – high

D. Spillway Design Flood — PMF

E. PMP

1. Dam located in Zone 6, (close to boundary of Zone 1)
   PMP = 22.3 inches (200 sq. mi – 24 hr)

2. PMF must be adjusted for basin size.

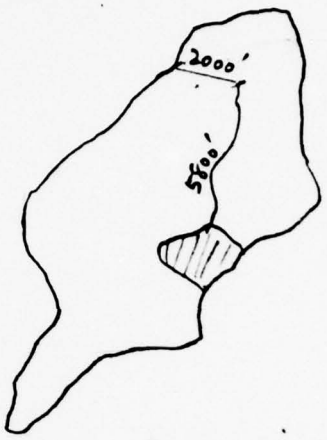
Duration	% Factor (for 10 sq. mi.) Zone 6	Zone 1	Used	Reduction Factor*
0-6	112	111	112	0.80
0-12	123	123	123	
0-24	132	133	133	
0-48	142	142	142	

* page 48 "D.S.D."

BY Py DATE 1/8/79 Morristown Reservoir Dam JOB NO. J-783 B

CKD GED DATE 2-15-79 SHEET NO. 1 OF 12

F. DETERMINE TIME OF CONCENTRATION



1. Majority area of watershed is woodland

2. Main channel is about 5800' stream & 2000' overland flow

3. Estimated slopes

   Overland : $\frac{250}{2000} = 12.5\%$

   Stream : $\frac{170}{5800} = 2.9\%$

4. Estimate T_c based on average velocity and lengths

	Slope	Velocity	remarks
Overland flow	12.5%	1 fps	Wooded
Stream channel	2.9%	3.2 fps	gutter

$$T_c = \left[\frac{2000}{1} + \frac{5800}{3.2}\right] \div 3600 \doteq 1.06 \text{ hr.}$$

5. Estimate T_c from State DEP Nomograph

   $\Delta H = 420'$

   $L = 7800'$

   $T_c = 22$ min.

6. Estimate T_c from curve number method SCS (Tech Release 55 Fig. 3.3)

$L = 7800$

$$\text{Ave slope} = \frac{12.5 \times 2000 + 2.9 \times 5800}{7800} = 5.36\,\%$$

$CN = 80$

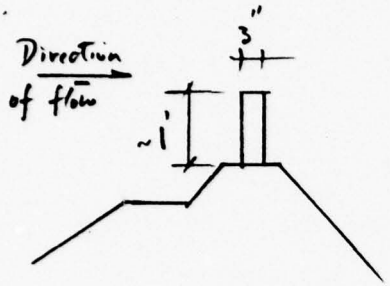
$\therefore L = 0.75$, $\quad T_c = \frac{0.75}{0.6} = 1.25$ hr.

Use $T_c = 1.0$ hr $\quad \therefore \boxed{L = 0.6 \text{ hr.}}$

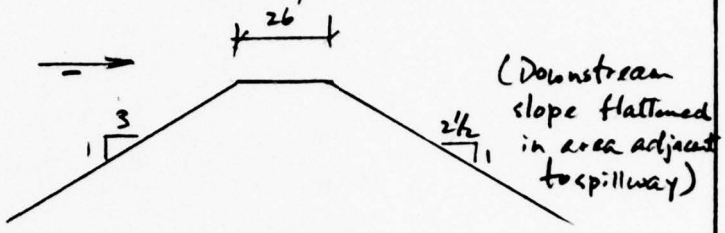
LANGAN ENGINEERING ASSOCIATES, INC.

SPILLWAY CAPACITY

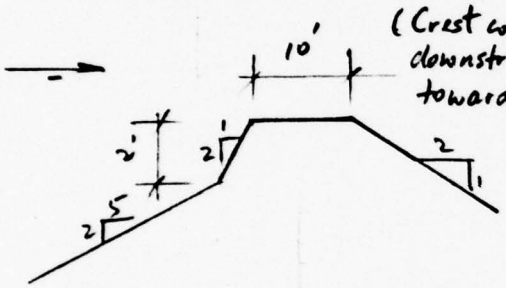
Spillway Section



Main Dam Section (Typ.)



Secondary Dike Section (Typ.)



$Q = C L H^{3/2}$ { L = Length (See schematic sketch); H = head

Since the flashboard on the spillway is anchored by steel cables, therefore consider the board as a permanent structure. Take spillway section as a broad-crested weir. Use c from Table 5-3 on page 5-46 of 'Handbook of Hydraulics' by King & Brater (5th Ed.)

Use $c = 3.32$

Both typical sections of the dam similar to weir of trapezoidal section, use ave. $c = 2.80$ (Table 5-9 on page 5-46 of King & Brater)

For sections with widened crest and flattened slopes use $c = 2.50$

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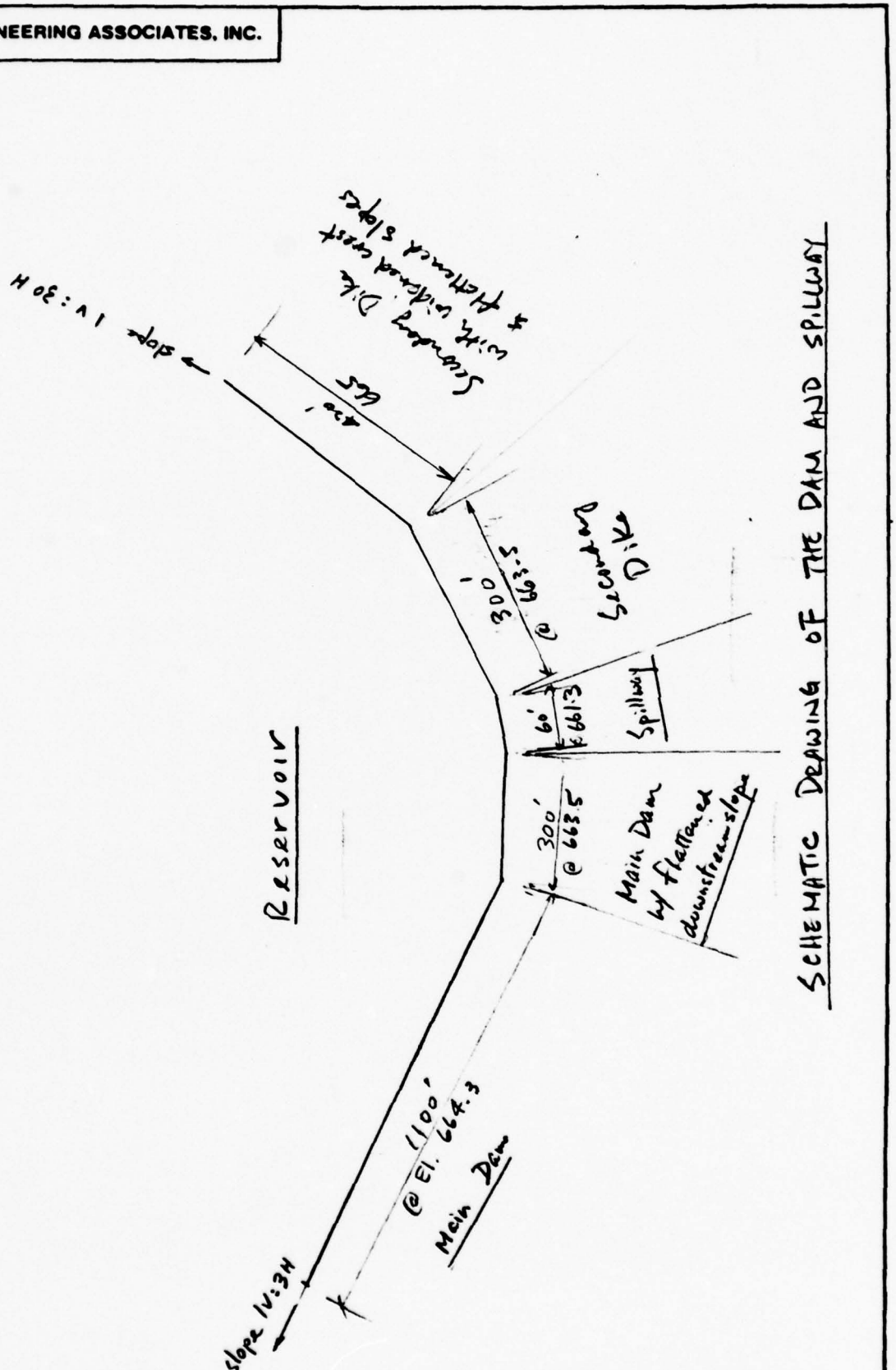

BY SJ DATE 1-12-79 Morristown Reservoir Dam JOB NO. J-763B

CKD GED DATE 2-15-79 SHEET NO. 5 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

BY Ry DATE 1-13-79 Morristown Reservoir Dam JOB NO. T-7838

CKD ED DATE 2-15-79 SHEET NO. 6 OF 12

Elev. (ft)	Main Dam						Spillway			Secondary Dike						Total Q_T (cfs)
	Typ. Section			Section adjacent to spillway						Typ. Section			Section w/ widened crest & flatter side slopes			
	H (ft)	L (ft)	Q (cfs)	H (ft)	L (ft)	Q (cfs)	H (ft)	L (ft)	Q (cfs)	H (ft)	L (ft)	Q (cfs)	H (ft)	L (ft)	Q (cfs)	
661.3							0	60								
662.3							1	60	199							199
663.5				0			2.2	60	650	0						650
664.3	0			0.8	300	537	3.0	60	1035	0.8	300	601				1572
665.0	0.7	1101	1805	1.5	300	1378	3.7	60	1418	1.5	300	1543	0			6144
666.0	1.7	1103	6846	2.5	300	2965	4.7	60	2030	2.5	300	3320	1	435	1088	16249
667.0	2.7	1102	13714	3.5	300	4911	5.7	60	2711	3.5	300	5500	2	450	3182	30018

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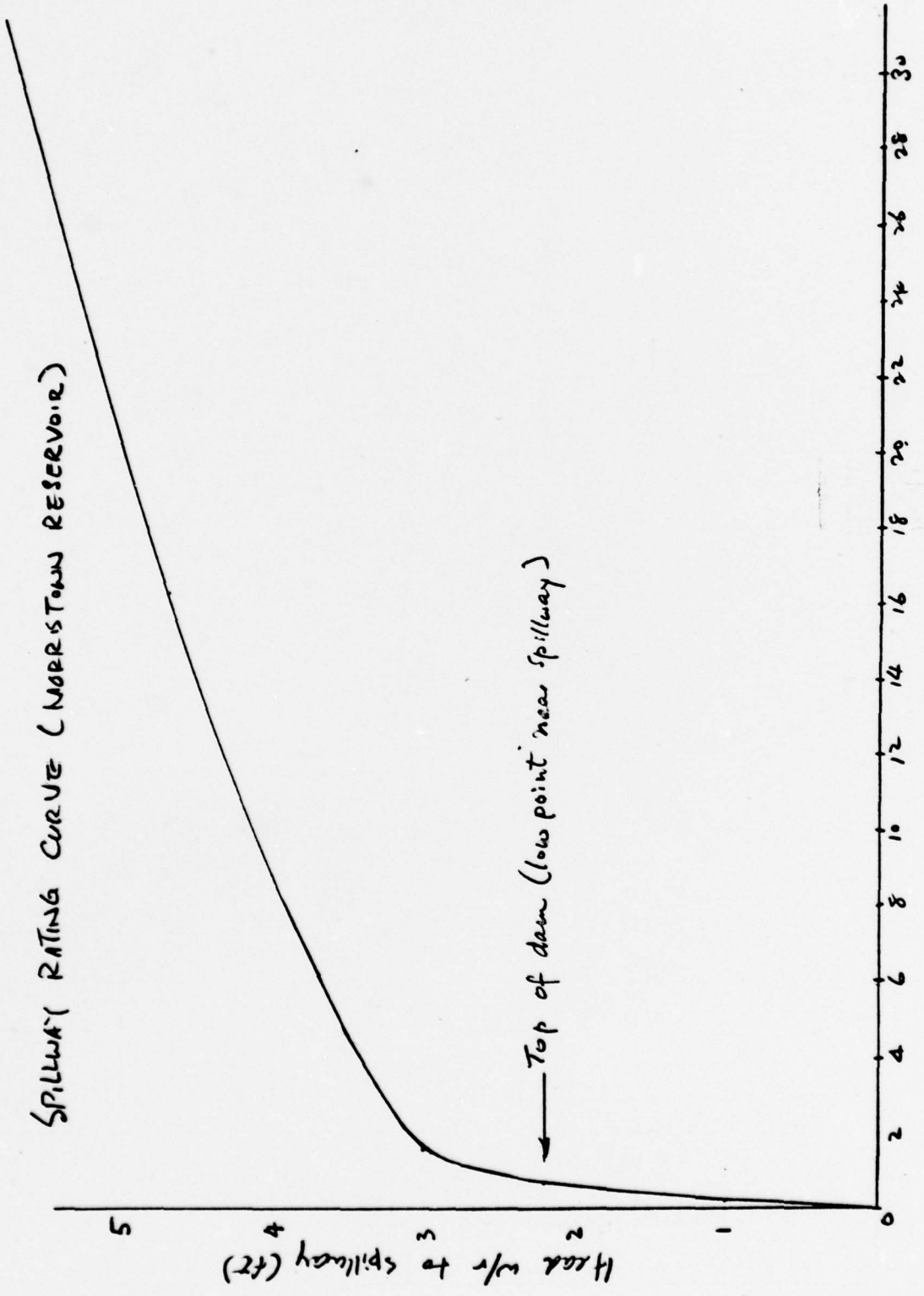


BY Pg DATE 1-16-79 Morristown Reservoir Dam JOB NO. J-7838

CKD GOD DATE 2-15-79 SHEET NO. 7 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

Reservoir Storage Capacity

Assume a linear distribution for the increase of the area with elevation. Start at a zero storage at the crest of the spillway.

Area of Lake = 36.7 Acres

Perimeter of lake ≐ 5000 ft (measured from U.S.G.S. Topo. map)

Slopes at dam and its vincity is 1V.:3H.

Slopes in other area of dam vary from about 1V:4H to 1V.:7H. or flatter

Take average side slope of lake as 1V:4H.

Perimeter of lake increases as water level rises, however since perimeter at lake level is approximate (measured to nearest hundred-foot) ∴ assume it is constant with water level*

∴ for every foot of water above crest of spillway, the area of lake increases by $\frac{4(5000)}{43560} \doteq 0.5$ acres

Elev. (ft)	H (ft)	Increase in Lake Area (Acres)	Area of Lake (Acres)	Equivalent square method* Le (ft)	Area (Acres)
661.3	0		36.7	1264.4	36.7
662.3	1	0.5	37.2	1272.4	37.2
663.5	2.2	1.1	37.8	1281.6	37.7
664.3	3.0	1.5	38.2	1288.4	38.1
665.0	3.7	1.9	38.6	1294	38.4
666.0	4.7	2.4	39.1	1302	38.9
667.0	5.7	2.9	39.6	1310	39.4

* This assumption is acceptable as the result checks out very close with that obtained by using equivalent square method

BY DY DATE 1-13-79 Morristown Reservoir Dam JOB NO. J-783B

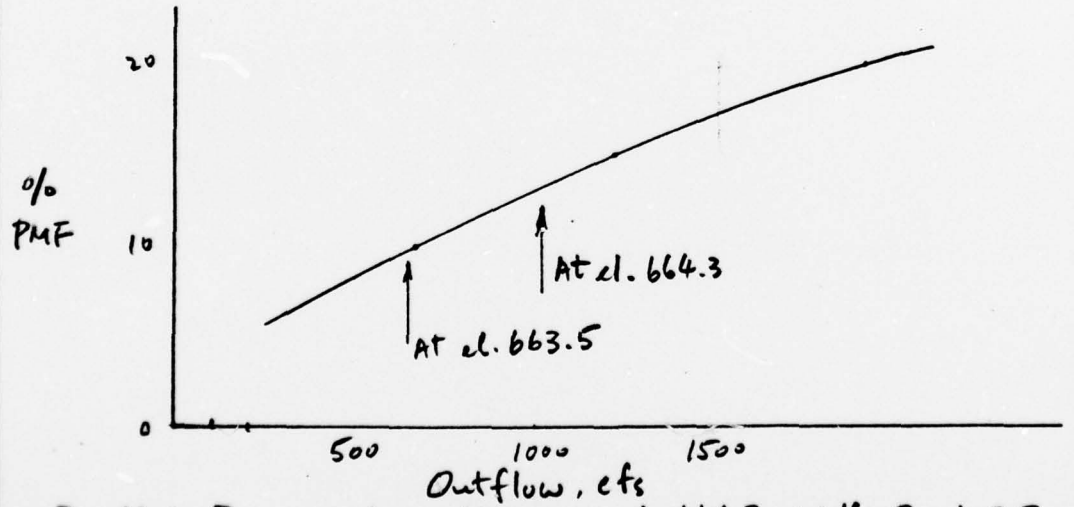
CKD GED DATE 2.15.79 SHEET NO. 8 OF 12

SUMMARY OF HYDROGRAPH AND FLOOD ROUTING

1. Hydrograph and routing calculated using HEC-1
2. PMF for Morristown Reservoir is 10,169 cfs
   (routed to 10,205 cfs)
3. Routing indicates main dam will overtop by approximately 1.1 ft for PMF. However the low spots in the vicinity of the spillway will overtop by approximately 1.9 ft for PMF.

OVERTOPPING POTENTIAL

1. Various % of PMF have been routed using HEC 1
2. Plot peak outflow vs % PMF



3. Main Dam overtops at approx. el. 664.3 with Q = 1035 cfs, however the low spot in the vicinity of the spillway overtop at el 663.5 with Q = 650 cfs, ∴ dam can pass approx. 9.9 % of the PMF.

DRAWDOWN ANALYSIS

1. Outlet Structure

1-18" ϕ blow-off pipe
2-12" ϕ supply pipes

For analysis purpose, assume all pipes are functional and used in full capacity

2. Outlet Capacity

a. Elevation of centerline of outfall end of pipe = 610.0 (assumed)

b. el. of lake = 661.3

c. Pipe capacity based on

$$Q = C_p H^{1/2} \quad \text{where } C_p = A_p \sqrt{\frac{2g}{1+K_m+K_p L}}$$

A_p for 18" ϕ pipe = 1.77 ft²
A_p for 12" ϕ pipe = 0.785 ft²

use $K_m = 0.9$ (Handbook of hydraulics, P.6-18)

use $n = 0.014$, $K_p = 0.0211$ for 18" ϕ (Exhibit 3-4 on pg 5-4 of 'Baltimore County, Storm Water Management Policy')
$K_p = 0.0363$ for 12" ϕ

$$C_p = 1.77 \sqrt{\frac{64.4}{1+0.9+0.0211\times 400}} = 4.417 \text{ for } 18'' \phi$$

$$C_p = 0.785 \sqrt{\frac{64.4}{1+0.9+0.0211\times 400}} = 1.959 \text{ for } 12'' \phi$$

∴ for 18" ϕ pipe

$$Q = 4.417 H^{1/2}$$

for 12" ϕ pipe $Q = 1.959 H^{1/2}$

LANGAN ENGINEERING ASSOCIATES, INC.

Elev.	Head	Q (cfs) 18"ϕ	2-12"ϕ	Total
661.3	51.3	31.6	28.1	59.7
655.0	45	29.6	26.3	55.9
650.0	40	27.9	24.8	52.7
645.0	35	26.1	23.2	49.3
640.0	30	24.2	21.5	45.7
635.0	25	22.1	19.6	41.7
630.0	20	19.8	17.5	37.3
625.0	15	17.1	15.2	32.3
620.0	10	14.0	12.4	26.4
615.0	5	9.9	8.8	16.7
610.0	0			

3. Storage Capacity

a. Estimated storage below spillway is 900 ac ft

b. Assume area varies linearly with height,
assume bottom of lake at 620',
area ≐ 7 ac.

Elev.	Acres	Δ Storage (ac-ft)	Total Storage
661.3	36.7		900 ac.ft.
		215	
655.0	32.0		
		152	
650.0	28.6		
		134	
645.0	25.0		
		116	
640.0	21.4		
		98	
635.0	17.8		
		80	
630.0	14.2		
		62	
625.0	10.6		
		43	
620.0	7		

BY Dyf DATE 1-15-79 Morristown Dam Reservoir JOB NO. J-7833

CKD TED DATE 2-15-79 SHEET NO. 11 OF 12

LANGAN ENGINEERING ASSOCIATES, INC.

4. Assume inflow to be 2 cfs/sq.mi

$Q_{in} = 2.15 \times 2 = 4.3$ cfs

Elev. (ft)	Q_{out} (cfs)	$Q_{out\,avg}$ (cfs)	Q_{net}* (cfs)	Storage (Ac.-Ft.)	Δt (hr.)	$\Sigma \Delta t$ (hr.)
661.3	59.7	57.8	53.5	215	49	
655.0	55.9	54.3	50.0	182	37	
650.0	52.7	51.0	46.7	134	35	
645.0	49.3	47.5	43.2	116	32	
640.0	45.7	43.7	39.4	98	30	
635.0	41.7	39.5	35.2	80	28	
630.0	37.3	34.8	30.5	62	25	
625.0	32.3	29.4	25.1	43	21	
620.0	26.4					257

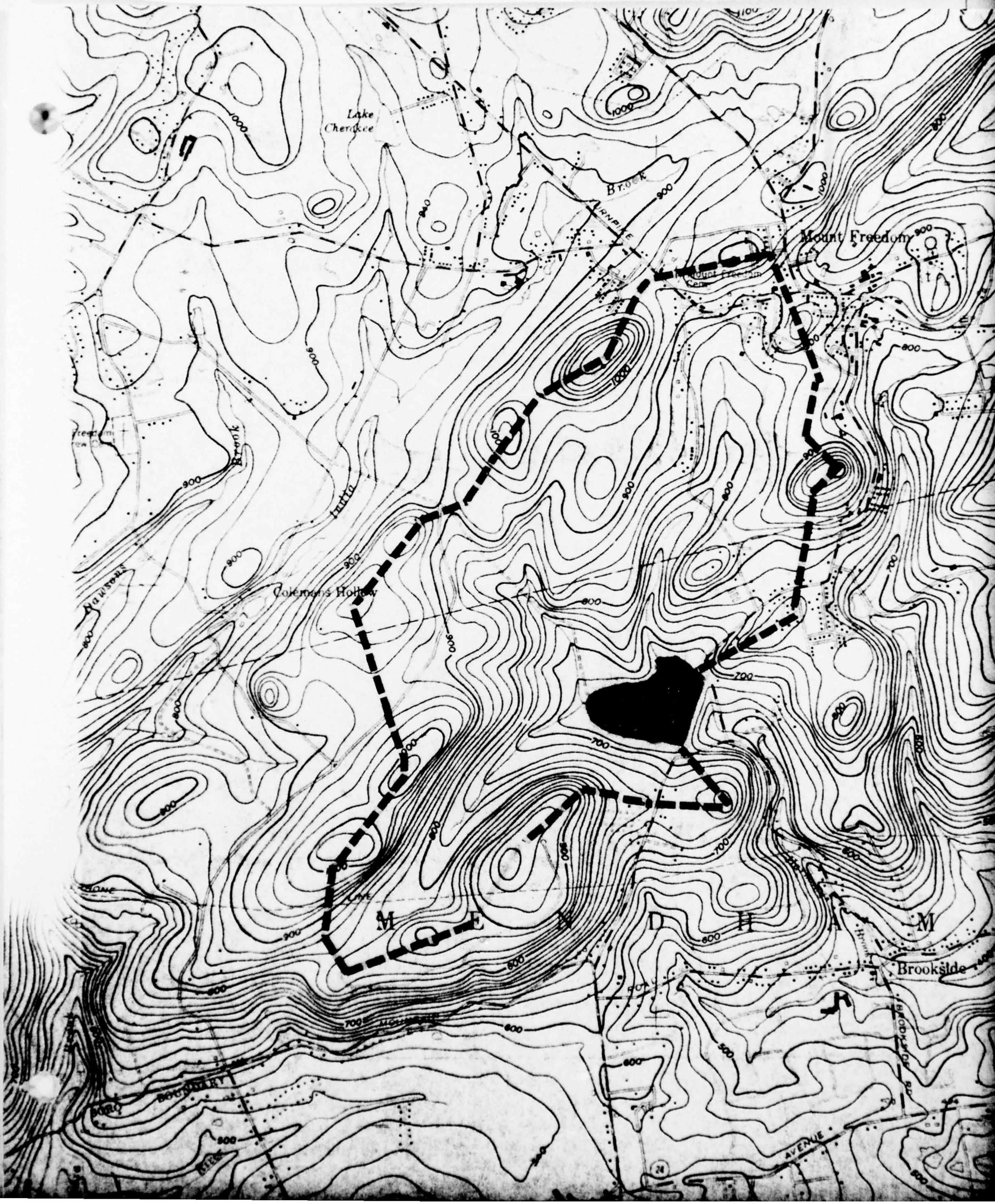
or 10.7 Days

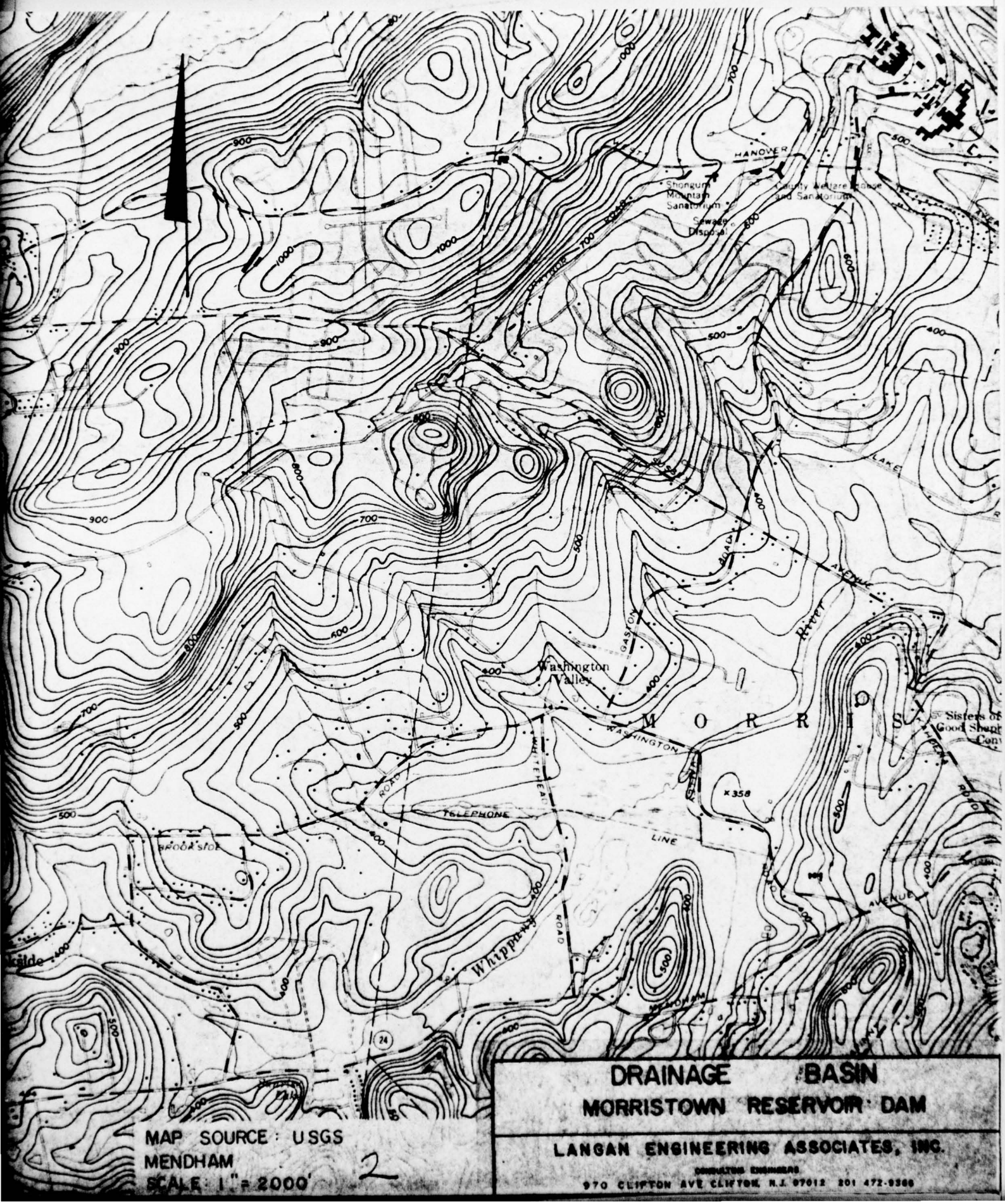
* $Q_{net} = Q_{out\,avg} - Q_{in}$

$= Q_{out\,avg} - 4.3$

BY. Dy DATE 1-15-79 Morristown Dam Reservoir JOB NO. I-783 B

CKD GED DATE 2-15-79 SHEET NO. 12 OF 12


Lake Cherokee
Brook
Mount Freedom
Colemans Hollow
Brook
M E N D H A M
Brookside


HANOVER
Shongum Mountain Sanatorium
County Welfare Home and Sanatorium
Sewage Disposal
LAKE
AVENUE
Washington Valley
MORRISTOWN
Sisters of Good Shepherd
WASHINGTON
TELEPHONE
LINE
ROAD
Whippany
ROAD
MAP SOURCE: USGS
MENDHAM
SCALE 1" = 2000'
2
DRAINAGE BASIN
MORRISTOWN RESERVOIR DAM
LANGAN ENGINEERING ASSOCIATES, INC.
CONSULTING ENGINEERS
970 CLIFTON AVE CLIFTON, N.J. 07012 201 472-9366

HEC-1 OUTPUT

MORRISTOWN RESERVOIR DAM

```
;HOROUT1     13:26 FEB 12,'79

1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  25 SEP 78
 **********
     1                A        MORRISTOWN RESERVOIR DAM
     2                A         INFLOW HYDROGRAPH AND ROUTING
     3                A         N.J. DAM INSPECTION
     4                B     200        0       15        0        0        0        0        0        0        0
     5                B1      3
     6                K                1                                                  1
     7                K1   COMPUTE HYDROGRAPH
     8                M       1        2     2.15                             0.8
     9                P              22.3      112      123      133      142
    10                T                                                          1      .15
    11                W2             0.6
    12                X      -2                1
    13                K       1        2                                         1
    14                K1   ROUTING COMPUTATIONS
    15                Y                                 1
    16                Y1      1                                                          -1
    17                Y4  661.3    662.3    663.5    664.3    665.0    666.0    667.0
    18                Y5      0      119      650     1572     6144    16219    30018
    19                $A   36.7     37.2     37.8     38.2     38.6     39.1     39.6
    20                $E  661.3    662.3    663.5    664.3    665.0    666.0    667.0
    21                $$  661.3
    22                $D  663.5
    23                K      99
1
                              PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                      RUNOFF HYDROGRAPH AT          1
                                      ROUTE HYDROGRAPH TO           2
                                      END OF NETWORK


1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  25 SEP 78
 **********

 RUN  DATE# 79/02/09.
      TIME# 13.47.50.
```

MORRISTOWN RESERVOIR DAM
INFLOW HYDROGRAPH AND ROUTING
N.J. DAM INSPECTION

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
200	0	15	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			3	0	0	0			

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

COMPUTE HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.15	0.00	2.15	.80	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.30	112.00	123.00	133.00	142.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.15	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .60

RECESSION DATA
STRTQ= -2.00 QRCSN= 0.00 RTIOR= 1.00

UNIT HYDROGRAPH 14 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .60 VOL= 1.00

349.	1151.	1428.	1141.	635.	365.	207.	119.	68.	39.
22.	13.	7.	2.						

0
END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.00	0.00	.00	4.	1.02	1.15	101	.03	0.00	.03	4.
1.01	.30	2	.00	0.00	.00	4.	1.02	1.30	102	.03	0.00	.03	4.
1.01	.45	3	.00	0.00	.00	4.	1.02	1.45	103	.03	0.00	.03	4.
1.01	1.00	4	.00	0.00	.00	4.	1.02	2.00	104	.03	0.00	.03	4.
1.01	1.15	5	.00	0.00	.00	4.	1.02	2.15	105	.03	0.00	.03	4.

1.01	1.30	6	.00	0.00	.00	4.	1.02	2.30	106	.03	0.00	.03	4.
1.01	1.45	7	.00	0.00	.00	4.	1.02	2.45	107	.03	0.00	.03	4.
1.01	2.00	8	.00	0.00	.00	4.	1.02	3.00	108	.03	0.00	.03	4.
1.01	2.15	9	.00	0.00	.00	4.	1.02	3.15	109	.03	0.00	.03	4.
1.01	2.30	10	.00	0.00	.00	4.	1.02	3.30	110	.03	0.00	.03	4.
1.01	2.45	11	.00	0.00	.00	4.	1.02	3.45	111	.03	0.00	.03	4.
1.01	3.00	12	.00	0.00	.00	4.	1.02	4.00	112	.03	0.00	.03	4.
1.01	3.15	13	.00	0.00	.00	4.	1.02	4.15	113	.03	0.00	.03	4.
1.01	3.30	14	.00	0.00	.00	4.	1.02	4.30	114	.03	0.00	.03	4.
1.01	3.45	15	.00	0.00	.00	4.	1.02	4.45	115	.03	0.00	.03	4.
1.01	4.00	16	.00	0.00	.00	4.	1.02	5.00	116	.03	0.00	.03	4.
1.01	4.15	17	.00	0.00	.00	4.	1.02	5.15	117	.03	0.00	.03	4.
1.01	4.30	18	.00	0.00	.00	4.	1.02	5.30	118	.03	0.00	.03	4.
1.01	4.45	19	.00	0.00	.00	4.	1.02	5.45	119	.03	0.00	.03	4.
1.01	5.00	20	.00	0.00	.00	4.	1.02	6.00	120	.03	0.00	.03	4.
1.01	5.15	21	.00	0.00	.00	4.	1.02	6.15	121	.08	.04	.04	20.
1.01	5.30	22	.00	0.00	.00	4.	1.02	6.30	122	.08	.04	.04	71.
1.01	5.45	23	.00	0.00	.00	4.	1.02	6.45	123	.08	.04	.04	134.
1.01	6.00	24	.00	0.00	.00	4.	1.02	7.00	124	.08	.04	.04	184.
1.01	6.15	25	.01	0.00	.01	4.	1.02	7.15	125	.08	.04	.04	213.
1.01	6.30	26	.01	0.00	.01	4.	1.02	7.30	126	.08	.04	.04	229.
1.01	6.45	27	.01	0.00	.01	4.	1.02	7.45	127	.08	.04	.04	238.
1.01	7.00	28	.01	0.00	.01	4.	1.02	8.00	128	.08	.04	.04	243.
1.01	7.15	29	.01	0.00	.01	4.	1.02	8.15	129	.08	.04	.04	246.
1.01	7.30	30	.01	0.00	.01	4.	1.02	8.30	130	.08	.04	.04	248.
1.01	7.45	31	.01	0.00	.01	4.	1.02	8.45	131	.08	.04	.04	249.
1.01	8.00	32	.01	0.00	.01	4.	1.02	9.00	132	.08	.04	.04	249.
1.01	8.15	33	.01	0.00	.01	4.	1.02	9.15	133	.08	.04	.04	250.
1.01	8.30	34	.01	0.00	.01	4.	1.02	9.30	134	.08	.04	.04	250.
1.01	8.45	35	.01	0.00	.01	4.	1.02	9.45	135	.08	.04	.04	250.
1.01	9.00	36	.01	0.00	.01	4.	1.02	10.00	136	.08	.04	.04	250.
1.01	9.15	37	.01	0.00	.01	4.	1.02	10.15	137	.08	.04	.04	250.
1.01	9.30	38	.01	0.00	.01	4.	1.02	10.30	138	.08	.04	.04	250.
1.01	9.45	39	.01	0.00	.01	4.	1.02	10.45	139	.08	.04	.04	250.
1.01	10.00	40	.01	0.00	.01	4.	1.02	11.00	140	.08	.04	.04	250.
1.01	10.15	41	.01	0.00	.01	4.	1.02	11.15	141	.08	.04	.04	250.
1.01	10.30	42	.01	0.00	.01	4.	1.02	11.30	142	.08	.04	.04	250.
1.01	10.45	43	.01	0.00	.01	4.	1.02	11.45	143	.08	.04	.04	250.
1.01	11.00	44	.01	0.00	.01	4.	1.02	12.00	144	.08	.04	.04	250.
1.01	11.15	45	.01	0.00	.01	4.	1.02	12.15	145	.50	.46	.04	396.
1.01	11.30	46	.01	0.00	.01	4.	1.02	12.30	146	.50	.46	.04	877.
1.01	11.45	47	.01	0.00	.01	4.	1.02	12.45	147	.50	.46	.04	1473.
1.01	12.00	48	.01	0.00	.01	4.	1.02	13.00	148	.50	.46	.04	1950.
1.01	12.15	49	.03	0.00	.03	4.	1.02	13.15	149	.60	.56	.04	2250.
1.01	12.30	50	.03	0.00	.03	4.	1.02	13.30	150	.60	.56	.04	2518.
1.01	12.45	51	.03	0.00	.03	4.	1.02	13.45	151	.60	.56	.04	2747.
1.01	13.00	52	.03	0.00	.03	4.	1.02	14.00	152	.60	.56	.04	2910.
1.01	13.15	53	.04	0.00	.04	4.	1.02	14.15	153	.75	.71	.04	3054.
1.01	13.30	54	.04	0.00	.04	4.	1.02	14.30	154	.75	.71	.04	3280.
1.01	13.45	55	.04	0.00	.04	4.	1.02	14.45	155	.75	.71	.04	3523.

1.01	14.15	57	.05	0.00	.05	4.	1.02	15.15	157	.76	.72	.04	3820.
1.01	14.30	58	.05	0.00	.05	4.	1.02	15.30	158	1.52	1.48	.04	4157.
1.01	14.45	59	.05	0.00	.05	4.	1.02	15.45	159	4.25	4.21	.04	6033.
1.01	15.00	60	.05	0.00	.05	4.	1.02	16.00	160	1.06	1.03	.04	9180.
1.01	15.15	61	.05	0.00	.05	4.	1.02	16.15	161	.70	.66	.04	10169.
1.01	15.30	62	.10	0.00	.10	4.	1.02	16.30	162	.70	.66	.04	8808.
1.01	15.45	63	.29	.11	.18	42.	1.02	16.45	163	.70	.66	.04	6667.
1.01	16.00	64	.07	.03	.04	140.	1.02	17.00	164	.70	.66	.04	5386.
1.01	16.15	65	.05	.01	.04	200.	1.02	17.15	165	.55	.51	.04	4596.
1.01	16.30	66	.05	.01	.04	190.	1.02	17.30	166	.55	.51	.04	4009.
1.01	16.45	67	.05	.01	.04	140.	1.02	17.45	167	.55	.51	.04	3555.
1.01	17.00	68	.05	.01	.04	105.	1.02	18.00	168	.55	.51	.04	3247.
1.01	17.15	69	.04	0.00	.04	82.	1.02	18.15	169	.04	.01	.04	2897.
1.01	17.30	70	.04	0.00	.04	59.	1.02	18.30	170	.04	.01	.04	2220.
1.01	17.45	71	.04	0.00	.04	39.	1.02	18.45	171	.04	.01	.04	1440.
1.01	18.00	72	.04	0.00	.04	24.	1.02	19.00	172	.04	.01	.04	824.
1.01	18.15	73	.00	0.00	.00	15.	1.02	19.15	173	.04	.01	.04	483.
1.01	18.30	74	.00	0.00	.00	11.	1.02	19.30	174	.04	.01	.04	291.
1.01	18.45	75	.00	0.00	.00	8.	1.02	19.45	175	.04	.01	.04	184.
1.01	19.00	76	.00	0.00	.00	6.	1.02	20.00	176	.04	.01	.04	122.
1.01	19.15	77	.00	0.00	.00	5.	1.02	20.15	177	.04	.01	.04	86.
1.01	19.30	78	.00	0.00	.00	5.	1.02	20.30	178	.04	.01	.04	66.
1.01	19.45	79	.00	0.00	.00	5.	1.02	20.45	179	.04	.01	.04	55.
1.01	20.00	80	.00	0.00	.00	4.	1.02	21.00	180	.04	.01	.04	49.
1.01	20.15	81	.00	0.00	.00	4.	1.02	21.15	181	.04	.01	.04	45.
1.01	20.30	82	.00	0.00	.00	4.	1.02	21.30	182	.04	.01	.04	44.
1.01	20.45	83	.00	0.00	.00	4.	1.02	21.45	183	.04	.01	.04	44.
1.01	21.00	84	.00	0.00	.00	4.	1.02	22.00	184	.04	.01	.04	44.
1.01	21.15	85	.00	0.00	.00	4.	1.02	22.15	185	.04	.01	.04	44.
1.01	21.30	86	.00	0.00	.00	4.	1.02	22.30	186	.04	.01	.04	44.
1.01	21.45	87	.00	0.00	.00	4.	1.02	22.45	187	.04	.01	.04	44.
1.01	22.00	88	.00	0.00	.00	4.	1.02	23.00	188	.04	.01	.04	44.
1.01	22.15	89	.00	0.00	.00	4.	1.02	23.15	189	.04	.01	.04	44.
1.01	22.30	90	.00	0.00	.00	4.	1.02	23.30	190	.04	.01	.04	44.
1.01	22.45	91	.00	0.00	.00	4.	1.02	23.45	191	.04	.01	.04	44.
1.01	23.00	92	.00	0.00	.00	4.	1.03	0.00	192	.04	.01	.04	44.
1.01	23.15	93	.00	0.00	.00	4.	1.03	.15	193	0.00	0.00	0.00	41.
1.01	23.30	94	.00	0.00	.00	4.	1.03	.30	194	0.00	0.00	0.00	33.
1.01	23.45	95	.00	0.00	.00	4.	1.03	.45	195	0.00	0.00	0.00	23.
1.02	0.00	96	.00	0.00	.00	4.	1.03	1.00	196	0.00	0.00	0.00	15.
1.02	.15	97	.03	0.00	.03	4.	1.03	1.15	197	0.00	0.00	0.00	10.
1.02	.30	98	.03	0.00	.03	4.	1.03	1.30	198	0.00	0.00	0.00	8.
1.02	.45	99	.03	0.00	.03	4.	1.03	1.45	199	0.00	0.00	0.00	6.
1.02	1.00	100	.03	0.00	.03	4.	1.03	2.00	200	0.00	0.00	0.00	5.
									SUM	25.33	20.49	4.84	114516.
										(643.)	(521.)	(123.)	(3242.73)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10169.	4256.	1178.	573.	114537.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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INCHES	18.41	20.39	20.65	20.65
MM	467.73	517.85	524.47	524.47
AC-FT	2110.	2337.	2366.	2366.
THOUS CU M	2603.	2882.	2919.	2919.

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HYDROGRAPH ROUTING

ROUTING COMPUTATIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	-1

STAGE	661.30	662.30	663.50	664.30	665.00	666.00	667.00
FLOW	0.00	119.00	650.00	1572.00	6144.00	16249.00	30018.00
SURFACE AREA=	37.	37.	38.	38.	39.	39.	40.
CAPACITY=	0.	37.	82.	112.	139.	178.	217.
ELEVATION=	661.	662.	664.	664.	665.	666.	667.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
661.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
663.5	0.0	0.0	0.

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	.15	1	.25	4.	0.	0.	661.3
1.01	.30	2	.50	4.	1.	0.	661.3
1.01	.45	3	.75	4.	1.	0.	661.3
1.01	1.00	4	1.00	4.	1.	0.	661.3
1.01	1.15	5	1.25	4.	1.	0.	661.3
1.01	1.30	6	1.50	4.	1.	0.	661.3
1.01	1.45	7	1.75	4	2.	0	661.3

1.01	1.45	7	1.75	4.	2.	0.	661.3
1.01	2.00	8	2.00	4.	2.	1.	661.3
1.01	2.15	9	2.25	4.	2.	1.	661.3
1.01	2.30	10	2.50	4.	2.	1.	661.3
1.01	2.45	11	2.75	4.	2.	1.	661.3
1.01	3.00	12	3.00	4.	2.	1.	661.3
1.01	3.15	13	3.25	4.	3.	1.	661.3
1.01	3.30	14	3.50	4.	3.	1.	661.3
1.01	3.45	15	3.75	4.	3.	1.	661.3
1.01	4.00	16	4.00	4.	3.	1.	661.3
1.01	4.15	17	4.25	4.	3.	1.	661.3
1.01	4.30	18	4.50	4.	3.	1.	661.3
1.01	4.45	19	4.75	4.	3.	1.	661.3
1.01	5.00	20	5.00	4.	3.	1.	661.3
1.01	5.15	21	5.25	4.	3.	1.	661.3
1.01	5.30	22	5.50	4.	3.	1.	661.3
1.01	5.45	23	5.75	4.	3.	1.	661.3
1.01	6.00	24	6.00	4.	3.	1.	661.3
1.01	6.15	25	6.25	4.	3.	1.	661.3
1.01	6.30	26	6.50	4.	4.	1.	661.3
1.01	6.45	27	6.75	4.	4.	1.	661.3
1.01	7.00	28	7.00	4.	4.	1.	661.3
1.01	7.15	29	7.25	4.	4.	1.	661.3
1.01	7.30	30	7.50	4.	4.	1.	661.3
1.01	7.45	31	7.75	4.	4.	1.	661.3
1.01	8.00	32	8.00	4.	4.	1.	661.3
1.01	8.15	33	8.25	4.	4.	1.	661.3
1.01	8.30	34	8.50	4.	4.	1.	661.3
1.01	8.45	35	8.75	4.	4.	1.	661.3
1.01	9.00	36	9.00	4.	4.	1.	661.3
1.01	9.15	37	9.25	4.	4.	1.	661.3
1.01	9.30	38	9.50	4.	4.	1.	661.3
1.01	9.45	39	9.75	4.	4.	1.	661.3
1.01	10.00	40	10.00	4.	4.	1.	661.3
1.01	10.15	41	10.25	4.	4.	1.	661.3
1.01	10.30	42	10.50	4.	4.	1.	661.3
1.01	10.45	43	10.75	4.	4.	1.	661.3
1.01	11.00	44	11.00	4.	4.	1.	661.3
1.01	11.15	45	11.25	4.	4.	1.	661.3
1.01	11.30	46	11.50	4.	4.	1.	661.3
1.01	11.45	47	11.75	4.	4.	1.	661.3
1.01	12.00	48	12.00	4.	4.	1.	661.3
1.01	12.15	49	12.25	4.	4.	1.	661.3
1.01	12.30	50	12.50	4.	4.	1.	661.3
1.01	12.45	51	12.75	4.	4.	1.	661.3
1.01	13.00	52	13.00	4.	4.	1.	661.3
1.01	13.15	53	13.25	4.	4.	1.	661.3
1.01	13.30	54	13.50	4.	4.	1.	661.3
1.01	13.45	55	13.75	4.	4.	1.	661.3
1.01	14.00	56	14.00	4.	4.	1.	661.3
1.01	14.15	57	14.25	4.	4.	1.	661.3

1.01	14.30	58	14.50	4.	4.	1.	661.3
1.01	14.45	59	14.75	4.	4.	1.	661.3
1.01	15.00	60	15.00	4.	4.	1.	661.3
1.01	15.15	61	15.25	4.	4.	1.	661.3
1.01	15.30	62	15.50	4.	4.	1.	661.3
1.01	15.45	63	15.75	42.	5.	2.	661.3
1.01	16.00	64	16.00	140.	11.	3.	661.4
1.01	16.15	65	16.25	200.	21.	7.	661.5
1.01	16.30	66	16.50	190.	33.	10.	661.6
1.01	16.45	67	16.75	140.	41.	13.	661.6
1.01	17.00	68	17.00	105.	46.	14.	661.7
1.01	17.15	69	17.25	82.	49.	15.	661.7
1.01	17.30	70	17.50	59.	51.	16.	661.7
1.01	17.45	71	17.75	39.	51.	16.	661.7
1.01	18.00	72	18.00	24.	49.	15.	661.7
1.01	18.15	73	18.25	15.	47.	15.	661.7
1.01	18.30	74	18.50	11.	45.	14.	661.7
1.01	18.45	75	18.75	8.	43.	13.	661.7
1.01	19.00	76	19.00	6.	41.	13.	661.6
1.01	19.15	77	19.25	5.	38.	12.	661.6
1.01	19.30	78	19.50	5.	36.	11.	661.6
1.01	19.45	79	19.75	5.	34.	11.	661.6
1.01	20.00	80	20.00	4.	32.	10.	661.6
1.01	20.15	81	20.25	4.	30.	9.	661.6
1.01	20.30	82	20.50	4.	29.	9.	661.5
1.01	20.45	83	20.75	4.	27.	8.	661.5
1.01	21.00	84	21.00	4.	26.	8.	661.5
1.01	21.15	85	21.25	4.	24.	8.	661.5
1.01	21.30	86	21.50	4.	23.	7.	661.5
1.01	21.45	87	21.75	4.	22.	7.	661.5
1.01	22.00	88	22.00	4.	21.	6.	661.5
1.01	22.15	89	22.25	4.	20.	6.	661.5
1.01	22.30	90	22.50	4.	19.	6.	661.5
1.01	22.45	91	22.75	4.	18.	5.	661.4
1.01	23.00	92	23.00	4.	17.	5.	661.4
1.01	23.15	93	23.25	4.	16.	5.	661.4
1.01	23.30	94	23.50	4.	15.	5.	661.4
1.01	23.45	95	23.75	4.	15.	4.	661.4
1.02	0.00	96	24.00	4.	14.	4.	661.4
1.02	.15	97	24.25	4.	13.	4.	661.4
1.02	.30	98	24.50	4.	13.	4.	661.4
1.02	.45	99	24.75	4.	12.	4.	661.4
1.02	1.00	100	25.00	4.	12.	4.	661.4
1.02	1.15	101	25.25	4.	11.	3.	661.4
1.02	1.30	102	25.50	4.	11.	3.	661.4
1.02	1.45	103	25.75	4.	10.	3.	661.4
1.02	2.00	104	26.00	4.	10.	3.	661.4
1.02	2.15	105	26.25	4.	10.	3.	661.4
1.02	2.30	106	26.50	4.	9.	3.	661.4
1.02	2.45	107	26.75	4.	9.	3.	661.4
1.02	3.00	108	27.00	4.	9.	3.	661.4

AD-A066 337 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. MORRISTOWN RESERVOIR DAM (NJ 00352--ETC(U)
MAR 79 D J LEARY DACW61-78-C-0124

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2 OF 2
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1.02	3.15	109	27.25	4.	8.	2.	661.4
1.02	3.30	110	27.50	4.	8.	2.	661.4
1.02	3.45	111	27.75	4.	8.	2.	661.4
1.02	4.00	112	28.00	4.	8.	2.	661.4
1.02	4.15	113	28.25	4.	7.	2.	661.4
1.02	4.30	114	28.50	4.	7.	2.	661.4
1.02	4.45	115	28.75	4.	7.	2.	661.4
1.02	5.00	116	29.00	4.	7.	2.	661.4
1.02	5.15	117	29.25	4.	7.	2.	661.4
1.02	5.30	118	29.50	4.	7.	2.	661.4
1.02	5.45	119	29.75	4.	6.	2.	661.4
1.02	6.00	120	30.00	4.	6.	2.	661.4
1.02	6.15	121	30.25	20.	7.	2.	661.4
1.02	6.30	122	30.50	71.	9.	3.	661.4
1.02	6.45	123	30.75	134.	15.	5.	661.4
1.02	7.00	124	31.00	184.	24.	8.	661.5
1.02	7.15	125	31.25	213.	36.	11.	661.6
1.02	7.30	126	31.50	229.	48.	15.	661.7
1.02	7.45	127	31.75	238.	60.	18.	661.8
1.02	8.00	128	32.00	243.	71.	22.	661.9
1.02	8.15	129	32.25	246.	82.	25.	662.0
1.02	8.30	130	32.50	248.	93.	29.	662.1
1.02	8.45	131	32.75	249.	103.	32.	662.2
1.02	9.00	132	33.00	249.	112.	35.	662.2
1.02	9.15	133	33.25	250.	126.	38.	662.3
1.02	9.30	134	33.50	250.	153.	40.	662.4
1.02	9.45	135	33.75	250.	174.	42.	662.4
1.02	10.00	136	34.00	250.	191.	43.	662.5
1.02	10.15	137	34.25	250.	204.	44.	662.5
1.02	10.30	138	34.50	250.	214.	45.	662.5
1.02	10.45	139	34.75	250.	222.	46.	662.5
1.02	11.00	140	35.00	250.	228.	46.	662.5
1.02	11.15	141	35.25	250.	233.	47.	662.6
1.02	11.30	142	35.50	250.	236.	47.	662.6
1.02	11.45	143	35.75	250.	239.	47.	662.6
1.02	12.00	144	36.00	250.	242.	47.	662.6
1.02	12.15	145	36.25	396.	259.	49.	662.6
1.02	12.30	146	36.50	877.	341.	56.	662.8
1.02	12.45	147	36.75	1473.	522.	71.	663.2
1.02	13.00	148	37.00	1950.	936.	91.	663.7
1.02	13.15	149	37.25	2250.	1491.	110.	664.2
1.02	13.30	150	37.50	2518.	2494.	118.	664.4
1.02	13.45	151	37.75	2747.	2667.	119.	664.5
1.02	14.00	152	38.00	2910.	2869.	120.	664.5
1.02	14.15	153	38.25	3054.	3010.	121.	664.5
1.02	14.30	154	38.50	3280.	3205.	122.	664.6
1.02	14.45	155	38.75	3523.	3455.	123.	664.6
1.02	15.00	156	39.00	3712.	3656.	125.	664.6
1.02	15.15	157	39.25	3820.	3792.	125.	664.6
1.02	15.30	158	39.50	4157.	4043.	127.	664.7
1.02	15.45	159	39.75	6033.	5383.	135.	664.9

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1.02	16.00	160	40.00	9180.	8517.	148.	665.2
1.02	16.15	161	40.25	10169.	10205.	155.	665.4
1.02	16.30	162	40.50	8808.	9160.	151.	665.3
1.02	16.45	163	40.75	6667.	7085.	143.	665.1
1.02	17.00	164	41.00	5386.	5618.	136.	664.9
1.02	17.15	165	41.25	4596.	4820.	131.	664.8
1.02	17.30	166	41.50	4009.	4161.	128.	664.7
1.02	17.45	167	41.75	3555.	3678.	125.	664.6
1.02	18.00	168	42.00	3247.	3325.	123.	664.6
1.02	18.15	169	42.25	2897.	3003.	121.	664.5
1.02	18.30	170	42.50	2220.	2436.	117.	664.4
1.02	18.45	171	42.75	1440.	1662.	113.	664.3
1.02	19.00	172	43.00	824.	1353.	105.	664.1
1.02	19.15	173	43.25	483.	1019.	94.	663.8
1.02	19.30	174	43.50	291.	717.	84.	663.6
1.02	19.45	175	43.75	184.	577.	76.	663.3
1.02	20.00	176	44.00	122.	485.	68.	663.1
1.02	20.15	177	44.25	86.	402.	61.	662.9
1.02	20.30	178	44.50	66.	331.	55.	662.8
1.02	20.45	179	44.75	55.	273.	50.	662.6
1.02	21.00	180	45.00	49.	224.	46.	662.5
1.02	21.15	181	45.25	45.	186.	43.	662.5
1.02	21.30	182	45.50	44.	155.	40.	662.4
1.02	21.45	183	45.75	44.	130.	38.	662.3
1.02	22.00	184	46.00	44.	117.	36.	662.3
1.02	22.15	185	46.25	44.	112.	35.	662.2
1.02	22.30	186	46.50	44.	108.	33.	662.2
1.02	22.45	187	46.75	44.	104.	32.	662.2
1.02	23.00	188	47.00	44.	100.	31.	662.1
1.02	23.15	189	47.25	44.	96.	30.	662.1
1.02	23.30	190	47.50	44.	93.	29.	662.1
1.02	23.45	191	47.75	44.	90.	28.	662.1
1.03	0.00	192	48.00	44.	87.	27.	662.0
1.03	.15	193	48.25	41.	84.	26.	662.0
1.03	.30	194	48.50	33.	81.	25.	662.0
1.03	.45	195	48.75	23.	78.	24.	662.0
1.03	1.00	196	49.00	15.	74.	23.	661.9
1.03	1.15	197	49.25	10.	70.	22.	661.9
1.03	1.30	198	49.50	8.	66.	20.	661.9
1.03	1.45	199	49.75	6.	62.	19.	661.8
1.03	2.00	200	50.00	5.	59.	18.	661.8

PEAK OUTFLOW IS 10205. AT TIME 40.25 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	10205.	4203.	1170.	568.	113645.
CMS	289.	119.	33.	16.	3218.
INCHES		18.19	20.25	20.49	20.49
MM		461.93	514.42	520.39	520.39
AC-FT		2084.	2321.	2348.	2348.

9

THOUS CU M 2571. 2863. 2896. 2896.

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RUNOFF SUMMARY, AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	10169.	4256.	1178.	573.	2.15
		(287.95)(	120.52)(	33.36)(	16.22)(	5.57)
ROUTED TO	2	10205.	4203.	1170.	568.	2.15
		(288.99)(	119.02)(	33.14)(	16.09)(	5.57)

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	661.30	661.30	663.50
STORAGE	0.	0.	82.
OUTFLOW	0.	0.	650.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.00	665.40	1.90	155.	10205.	6.75	40.25	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
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1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  25 SEP 78
 **********
1                              PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                      RUNOFF HYDROGRAPH AT          1
                                      ROUTE HYDROGRAPH TO           2
                                      END OF NETWORK


1**********
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION      JULY 1978
   LAST MODIFICATION  25 SEP 78
 **********

 RUN  DATE$ 79/02/12.
      TIME$ 14.41.24.


                      MORRISTOWN RESERVOIR DAM
                      % PMF
                      N.J. DAM INSPECTION

                                          JOB SPECIFICATION
                 NQ      NHR     NMIN     IDAY      IHR     IMIN     METRC     IPLT     IPRT    NSTAN
                200        0       15        0        0        0         0        0        4        0
                                          JOPER      NWT    LROPT    TRACE
                                              5        0        0        0


                                     MULTI-PLAN ANALYSES TO BE PERFORMED
                                          NPLAN= 1 NRTIO= 7 LRTIO= 1
                          RTIOS=    1.00     .50     .30     .25     .20     .15     .10


**********          **********          **********          **********          **********

                                     SUB-AREA RUNOFF COMPUTATION

                 COMPUTE HYDROGRAPH
```

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	2.15	0.00	2.15	.80	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.30	112.00	123.00	133.00	142.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.15	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .60

RECESSION DATA

STRTQ= -2.00 QRCSN= 0.00 RTIOR= 1.00

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.33	20.49	4.84	114516.
										(643.)	(521.)	(123.)	(3242.73)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING COMPUTATIONS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	-1

STAGE	661.30	662.30	663.50	664.30	665.00	666.00	667.00
FLOW	0.00	119.00	650.00	1572.00	6144.00	16249.00	30018.00
SURFACE AREA=	37.	37.	38.	38.	39.	39.	40.

CAPACITY=	0.	37.	82.	112.	139.	178.	217.
ELEVATION=	661.	662.	664.	664.	665.	666.	667.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
661.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
663.5	0.0	0.0	0.

PEAK OUTFLOW IS 10205. AT TIME 40.25 HOURS

PEAK OUTFLOW IS 5037. AT TIME 40.25 HOURS

PEAK OUTFLOW IS 3120. AT TIME 40.25 HOURS

PEAK OUTFLOW IS 2512. AT TIME 40.25 HOURS

PEAK OUTFLOW IS 1910. AT TIME 40.50 HOURS

PEAK OUTFLOW IS 1223. AT TIME 40.50 HOURS

PEAK OUTFLOW IS 669. AT TIME 40.75 HOURS

********** ********** ********** ********** **********

1

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7
				1.00	.50	.30	.25	.20	.15	.10
HYDROGRAPH AT	1	2.15	1	10169.	5084.	3051.	2542.	2034.	1525.	1017.
	(	5.57)	(	287.95)(	143.97)(	86.38)(	71.99)(	57.59)(	43.19)(	28.79)(

ROUTED TO	2	2.15	1	10205.	5037.	3120.	2512.	1910.	1223.	669.
	(	5.57)	(	288.99)(	142.62)(	88.35)(	71.13)(	54.07)(	34.64)(	18.95)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	661.30	661.30	663.50
STORAGE	0.	0.	82.
OUTFLOW	0.	0.	650.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	665.40	1.90	155.	10205.	6.75	40.25	0.00
.50	664.83	1.33	133.	5037.	5.50	40.25	0.00
.30	664.54	1.04	121.	3120.	4.50	40.25	0.00
.25	664.44	.94	118.	2512.	3.75	40.25	0.00
.20	664.35	.85	114.	1910.	2.75	40.50	0.00
.15	664.00	.50	101.	1223.	2.00	40.50	0.00
.10	663.52	.02	83.	669.	.25	40.75	0.00

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 25 SEP 78
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APPENDIX 5

REFERENCES

MORRISTOWN RESERVOIR DAM

APPENDIX 5

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